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Public Health Service
Dallas, Texas

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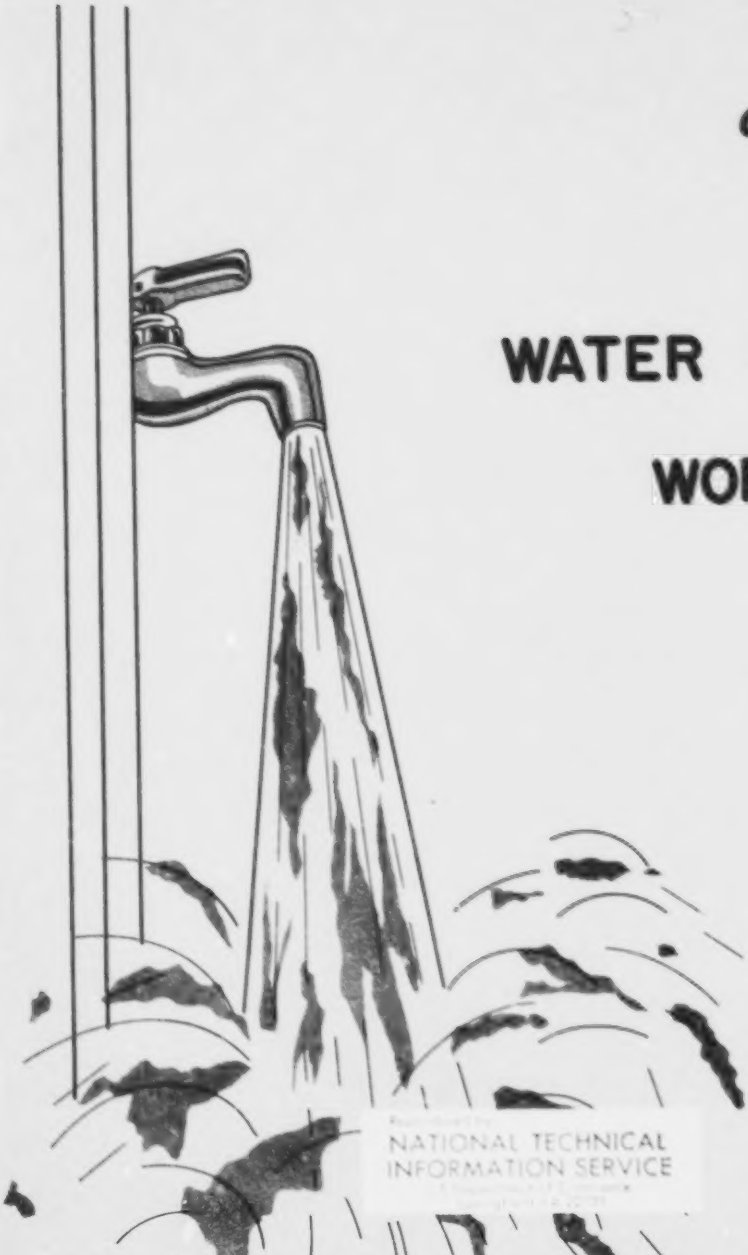

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Dallas, Texas

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of
WATER RESOURCES WORKSHOP

May 24-26, 1961
Hotel Dallas
Dallas, Texas

DEPARTMENT OF
HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

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FOREWORD

Proceedings of the Water Resources Workshop, held in Dallas, Texas, in May, 1961, are presented herein. This is the first meeting of its kind held by the Public Health Service and had as its goal "the development of procedures and policies that we hope will ultimately be those of the Public Health Service." Although it cannot be said that this goal was reached or even closely approached in many instances, the papers given and the ensuing discussions added to the understanding of all present of problems now faced by the Service in the field of water resource management and, hopefully, started processes that will eventually result in clear-cut policies and guides for all Regions. We believe this volume will make an interesting and valuable contribution toward this end.

Jerome H Svore

Jerome H. Svore

WATER QUALITY CONTROL AS A MAJOR FACTOR IN WATER RESOURCES MANAGEMENT

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INTRODUCTION

Federal development of water resources in the United States began in about 1822 when the Army Engineers were directed to plan and build the Chesapeake and Delaware Canal to improve the transportation system of the young Nation. Thus, commerce became the motivating factor for the initiation of a Federal water resources development program. A body of law with which to underwrite the development of the navigation on the inland waterways also began about this time.*

Our rivers formed the arteries of commerce and the great cities sprang up on the banks of these streams as a result of the waterways traffic. Pittsburg, Cincinnati, Chicago, St. Louis, and New Orleans became the centers of waterborne commerce.

The mere presence of these cities, their growing population and industry, located as they were in the river valleys, led naturally into a second great phase of water resources development - that of flood control. Periodically, the rivers would overflow their banks, sometimes in mighty torrents to take great tolls of life and property. The cities on the lower Mississippi River and on the Ohio were particularly susceptible to these devastations. Local flood control works were constructed, but invariably proved inadequate to cope with the more destructive floods. During the period 20 years before the Civil War, mighty debates arose in Congress over the propriety of the Federal Government entering the field of flood control. Flood control legislation had such able supporters as Abraham Lincoln and Henry Clay. It was not, however, until almost 10 years after the Civil War that the first comprehensive study of flood control for the lower Mississippi Valley was actually gotten under way. This resulted in the development of the Mississippi River Commission and ultimately a unified plan and the construction of the great levee system which now protects much of the Mississippi Valley. However, the great destructive floods of 1927 showed that levee protection was not sufficient and that other means of regulating the flood flows of the Mississippi and its tributaries would be necessary to protect life and property if a high degree of control were to be achieved. These means included dams and reservoirs, flood zoning and other local protection works.

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* Marshall Decision, 1824, Gibbons vs. Ogden.

A third new water resources development program was beginning to take shape during the last two decades of the 19th century. This one also motivated for economic reasons. National leadership began to recognize the need to conserve natural resources and to reclaim the areas, large blocks of western lands which had shown great capabilities for agricultural production, providing a supply of water was available. In 1902, the Federal Reclamation Act was passed which provided the initial authority for the construction of some of our great dams and water regulatory systems that we now have in the 17 western States. It became readily apparent to those charged with the development of the western lands that in order to make the most out of the water that had been stored, hydroelectric power generators could be operated by the same waters that supplied irrigation requirements. Thus, the hydroelectric development became an integral part of the reclamation movement. It was not long thereafter when it became apparent that reservoirs could be used for several purposes including the generation of hydroelectric power. Thus, the concept of public hydroelectric power began to take shape. In 1920 the Federal Power Commission was established in order to give parental guidance and direction to another lusty infant in the national water resources development family.

Such leaders as Senator George Norris of Nebraska had long dreamed of establishing a completely controlled river basin system where the most efficient use of both water and land would be promoted and developed to its highest degree. Bull Shoals Dam was built and produced power for war material during World War I. Shortly thereafter the first outlines of the TVA began to take shape. It was not, however, until 1933 that the full concept of integrated water resources development was brought to the construction stage. The TVA concept brought with it the consideration of water for recreation, for fishery. It pointed out that water was an attraction for industry. The TVA also focused attention on public health aspects of water resources development. Mosquito and malaria control, pollution abatement and water supply became an integral part of that development.

By 1935 Federal interest in water resources development programs for navigation, flood control, power, irrigation, recreation, municipal and industrial uses, pollution abatement and fisheries had either been an established fort or well on its way. For example, the first national conference on water pollution control was held in 1935 to discuss the role of the Federal government. The participants recognized the need for national policy on water pollution control. Between the period of 1935 and 1948 there were many bills introduced in the National Congress designed to throw Federal resources into the battle on pollution of the Nation's streams and lakes. One of these bills nearly succeeded in passage in 1944. However, as you all know, it was not until 1948 that the first Federal Water Pollution Control Act, P. L. 845, was enacted and amended to its present form in 1956 and is again undergoing strengthening and revision now.

In 1958, the national policy on provision for industrial and municipal water supply storage in Federal reservoirs was clarified in Title III of the Rivers and Harbors Act of 1958, better known to us as the Water Supply Act of 1958.

There have been increases in scope and variations of flood control such as exemplified by the Small Watersheds Flood Protection Act of 1955, and the inclusion of recreational benefits as a part of the economic justification of Federal water resources development projects in 1950. In addition to planning by individual agencies having primary responsibilities for carrying out the mandates of Congress, the TVA and the U. S. Study Commissions have been two different formal organizational approaches to achieving coordinated and integrated water resources planning, construction, and operation of water resources projects for multiple-purpose utilization.

QUALITY AND QUANTITY IMPACTS

There are two great characteristics of water which exercise profound influence on its usefulness. The first is quantity. Quantity was extremely important to the first uses of water, that is, of navigation. Quantity influences all of water resources development and uses. It is readily recognized that without quantity none of the uses we make of water today would be possible. However, the second characteristic, quality, while more subtle is nevertheless rapidly being recognized as important to utilization as is quantity. The rapid rise of population and industrialization in the United States has focused attention on quality as no other thing could have done. The quality of water as a constructive or destructive force had not been recognized until the latter part of the 19th century, and I dare say it had not completely been recognized in all of its aspects as of this day. Much of the interest in the quality of water resulted from work done by Public Health authorities and municipal water supply people. To be useful, water must be both plentiful in quantity and of good enough quality to be satisfactory for the purposes which it serves. Polluted water is often as useless as no water at all. The ocean is of comparatively little value for industrial and municipal water supplies except as a place of waste disposal.

In the earlier days people who were interested in obtaining high quality water for municipal and industrial purposes used the ground water available to them. When the quantity needed arose beyond the capacity of ground water to supply, they went to the surface streams. The usefulness of the surface streams in many instances proved to be of very short durations because the qualities rapidly deteriorated as a result of other persons trying to do the same thing upstream. Consequently, the cities and industries sought higher quality water from greater and greater distances. It has now become apparent that there are many places within our Nation in which there is very little high quality water remaining, even at great distances from the point of utilization. The facts of the matter are that high quality water which has never been polluted is becoming extremely limited. There is also recognition taking place that water should, and can be, cleaned up and reused. It is becoming increasingly obvious that the extravagant policy of using the water only once and discarding it cannot be tolerated much longer.

As competition for the available water supply becomes greater and greater the role which quality will play in the ability of our Nation's water supplies to meet the economic, public health, recreational, and esthetic needs will become correspondingly larger. I believe our need to control water quality will be continuous indefinitely. No longer should we think of water quality as a separate entity with respect to quantity. No longer should we accept the dictum that water can only be used once to satisfy our domestic and industrial requirements. No longer do we have the privilege of extravagant use of our water resources. Just as the desire for commerce in the early days brought attention to navigation; the construction of cities and agriculture lands in the river bottoms produced the need for flood control; the desire to reclaim the Federal acquired lands in the west for commercial reasons produced irrigation development; the need for regulation of a Federal power development program arose from interest in a supply of cheap electricity to move the wheels of industry, we have now come to the point where the spotlight of need is on quality. The Nation is becoming aware of the need for protection of the quality of its water supply. This is attested by the documented material gathered by the Senate Select Committee during the past two years and further substantiated by the interest, comments and recommendations made to the National Water Pollution Control Conference.

I believe there can be little question but that the star of water quality is arising to join the galaxie of national water development and water resources management programs and will outshine them all. I would venture to predict that within two decades water quality, its management and control will be the major water programs in the United States and recognized as such.

From the point of national investments represented by a sum of expenditures made by private, local and industrial agencies, by state agencies and by the Federal government for the purposes of water quality control are even now in excess of all other water investments. It is our job to see that these mighty forces are properly employed in an efficient and economic manner so that our national water supply needs can be met when they must be met.

The purpose of this paper is to attempt to provide you with some depth and perspective of the program which we all are a part. This is not a time for provincialism; it is a time for bold, imaginative action.

DISCUSSION

Lester M. Klashman
Regional Program Director, Division of Water Supply and Pollution Control, Public Health Service, Regions I & II, Department of Health, Education, and Welfare, New York, New York

I think it would be appropriate to refer to just a couple of paragraphs in Lenny Dworsky's recent paper which Carl mentioned to you before. One of the paragraphs of Lenny's paper I'd like to read goes as follows:

> "Notwithstanding the well-known relationship between flow and quality, the absence of a policy authorizing flow regulation of waterways as a part of the national multi-purpose water resource development program for water quality control on a non-reimbursable basis, recognizing that such flow regulation is not to be a substitute for sewage and waste treatment."

This is one of the very important factors that must be considered in this water quality control problem that we have.

The other two paragraphs that I would like to just throw out to you from Lenny's paper have to do with the relationship - our relationship between the Federal government and the states, and in this one he says:

> "Today, pollution control responsibility is shared between the Federal government and the states. Improved understanding of this Federal-state relationship is highly to be desired. There is no single formula to guide this relationship. Part will be determined by the course of legislation in the Congress. A large part will continue to emerge out of the long-term and continuous relationship between the Public Health Service and the state water pollution control agencies. Whatever the current status of the Federal-state division of responsibility, it should certainly be the Federal aim to provide effective back-up to state pollution control programs through research, technical aid, authorized enforcement, and other appropriate support."

And the last -

> "A somewhat new and important issue is the relationship between the Public Health Service and

> state agencies other than the official pollution control organization. Many states are playing increasingly active roles in water resource development. Water quality is of growing importance as an aspect of over-all water resource development and is closely related to the policies and programs of state water resource, conservation, and development, and fisheries agencies. Time and program operations will provide clarification of relationships between Federal pollution control activities and these agencies."

I think that we must recognize that our traditional relationship with the state health departments in this field of water quality is rapidly changing. Today, as all of you know, there are over 20 states with separate water pollution control agencies. Many of the states are considering a separate water resources agency. Up in our own region (New York State) the Governor has just signed legislation in which a new Water Resources Board has been formed in the Department of Conservation, with membership of five of the prime interested state agencies, and the state agency has the function of water pollution control as well as other water resources management responsibilities. I think that this is going to continue to happen in many of our other states. I would like to raise this question as to what our relationship must be with these new agencies -- Can we continue to maintain our traditional health orientation? With this, I'd like to open Keith's paper to discussion. Does anybody have any comments?

GENERAL DISCUSSION

HAGER: One of the comments you made in your discussion was that dilution should not be a substitute for treatment. My question is simply, "How come?"

KLASHMAN: Are you asking me to answer that? I think Keith has some very definite ideas on that.

KRAUSE: Well, I think this subject is going to come up again, and so I'm not making an answer to this at the moment. I think it is important that this be discussed. However, I think when Mel's paper comes up for discussion this will be involved, and I would prefer to defer any discussion at this time. However, I'm going to ask you a question now -- When you're dealing with bug count extremes that run into the several million, how many times are you going to have to do that before you get it down to drinking water standards by dilution?

KLASHMAN: Mr. Hager, do you have anything to say to that rhetorical question?

HAGER: Well, I'm on the spot. The problem there is perhaps a little difficult to answer because of lack of technical know-how or knowledge in this particular realm that I know of, perhaps. This is one of the reasons that I think we're all here -- to become informed -- but, how much consideration has been given in our work to what happens to the bug count downstream? We run oxygen sag curves up and down the stream and sideways; but as far as I know, we don't have any evidence to show as to what happens below a sewage outfall — something that we can hang our hat on, similar to this oxygen.

KLASHMAN: Do you mean as far as the bacteriological count is concerned?

HAGER: Yes. What happens downstream? I had a rather wicked experience with a State Health Department trying to get together evidence to hang a case on in regard to a poorly operated treatment plant. I picked up samples above and below, but we never could hang a case on them because the bug count below the sewage treatment plant was less than it was above the treatment plant. Bacteriologically, we didn't have a case.

REED: I think we've stumbled right at the very beginning on something rather pertinent that is going to come up again here in this conference for the next three days. First thing is, there're more questions than answers. We've already had two questions and one answer. So, I think this is the first thing we're going to have to recognize: In the first place there are no "pat answers." Every one of these problems is going to have to be approached with the local circumstances in mind, and those local circumstances will vary very widely. My experience the last couple of years indicates we're not only going to have to think in terms of low-flow augmentation where water is available, but we're going to have to think very seriously about water reuse, almost to an extreme extent, and to tertiary treatment. There are some places in this country where sooner or later we're going to get to the point where even though we would like to have low-flow augmentation, there's just not going to be the water there to use for this purpose. So I don't think we're going to have any "pat answers."

SCHEIDT: I don't want to get into the details and problems which were raised a moment ago because later on we are going to discuss in a little more detail the problems of economic and other considerations that enter into the problem that you raised. I wanted to bring this discussion for the moment back to a somewhat broader point of view to supplement what Keith said, because I think we're going to have to keep our sights on a pretty broad range of activities and on some broad general approaches to the whole problem of river basin development. I participated yesterday noon in a little seminar that I meet with once a month in Washington, in which the discussion was on the attitudes of Congress and the Senators with respect to this whole problem, and I was very much impressed with the remarks made at that conference by a member of the staff of Congress on the attitudes of the Senators from this point of view. They don't get down to it, they don't worry themselves too much about these minutiae or technological or economic formulae in detail the way we do, and as a matter of fact we have to, ourselves, work with them. They're concerned with broad objectives and what they can get. I was particularly impressed with the remarks of Senator Kerr and several others in the Senate on the approach to the problem of river basin planning which I think I'll pass on to you and I think we should keep it in mind. They don't have any "pat answers." They don't believe there's any one way of organizing or going about river basin planning or development -- no one best method of organizing, for example, a river basin commission, or river basin planning operation. They play it by ear in each area. I just wanted to pass this along to you fellows, because there are many different approaches to what we're going to have to tackle. I think we should keep this in mind.

KLASHMAN: Thanks very much. Does anybody else have any comments about this water quality control as a major factor in water resources management?

FLANNERY: I'd like to comment on an earlier point. My comment refers to your statement (Dworsky) and the 20-some states that now have some kind of a state water resources agency, the relationship of the Public Health Service to those state agencies and the traditional relationship with the State Health Departments. I think, that because the Public Health Service deals with water quality, which obviously refers to each of the numerous uses of water, our responsibility is immense. We have to maintain the traditional relationship with the Health Departments and the other agencies which may develop or already exist. That means that the Public Health Service representative may be the one who brings them together in some subtle persuasive way. This can't be something that's imposed upon them, but the Public Health Service, under this delegation of comprehensive planning has a greater responsibility than any other water agency at the Federal level. There is no agency, no private group, no one having any concern with water that is not also our concern, and this is a tremendous responsibility. I have no suggestion, of course, but it is fearsome.

DAVIS: With regard to these bugs in the stream, as Dick pointed out, they're pretty hard to measure. It depends on where you grab the sample in the stream. I think at this time we should recognize the fact that these technical details that the Sanitary Engineering Center can come out and be used very strongly on the firing line in interstate enforcement. Harold Clark a SEC bacteriologist can come out in court and say that "This is the bacteria count." He doesn't talk about coliform, he talks about streptococcus, and he talks about a particular animal that's swallowed it. By taking many counts we can take these things in, and before the eyes of the public this is what got victories at St. Joseph and Kansas City. Not BOD, our old stand-by, but these nebulous bacteria, these bugs, are going to sell the public when we start talking about health and safe drinking water. My point is that bacteria are not something that we can't use. We certainly can use them.

POPULATION FORECASTING - METHODOLOGIES AND MERITS

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Introduction

One of our primary tasks is to forecast the water demand for a designated area half a century hence. The water demand is a function of the number of people and the activities of these people. We will concern ourselves here with the number of people. We will further limit our concern to the forecast of population for the larger cities - the Standard Metropolitan Statistical Areas (SMSA's). This limitation, however, obviously necessitates a forecast of the country and other major subdivisions.

The task before us is to determine what will be the probable population in a given metropolitan area 50 years from now. Having estimated that, then what is the probable error of this estimate? The agency that makes most of the population projections - Bureau of the Census - has this to say about its own projections: "It should be borne in mind that the projections to 1980 are all quite speculative; and that the projections for the year 2000 are of the nature of a mathematical exercise." And we are required to go a decade or two beyond a point that is already 20 years removed from a time that only a very speculative forecast can be made. It is little wonder why so many souls become timid and attempt to shield themselves with a phrase such as, "These are projections and not predictions," or else to project such a wide range of growth possibilities that the forecast cannot miss if the city has a population explosion or a hydrogen explosion. We have no such escape clause. We must come up with a forecast.* Let's grant, without apology, that

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*The Bureau of the Census makes projections; the USPHS makes forecasts. The basic difference is this: The Bureau of Census postulates various conditions (combinations of birth, death and migration rates), each resulting in a different future population total. These are strictly projections. They are "if this - then that - " statements. No judgment is made as to which of these conditions are regarded as having the greatest likelihood of occuring. They don't "stand" on any particular one of their figures. We in the USPHS have to come to rest on _a_ figure, or at least a relatively narrow range, that we regard as being the most likely of many possibilities. When a figure is chosen to "stand on" by whatever rational method used, it becomes a forecast. That is the major difference. Some seem to be of the opinion that the word _project_ should be used rather than forecast because the latter implies more certainty than is warranted. The difference in the terminology has nothing to do with the degree of confidence the planner has in the figure itself.

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the likelihood of forecasting with precision is quite small. Since we grant that an error in forecasting will be made, then what data and knowledge can we use to minimize the error? Perhaps the best indicators will be past trends; especially, if they have been relatively consistent. Past trends may or may not prevail, but if the last 50 years indicate a stable trend, this may be our best source for predicting the next 50 years. What else do we have? To assume a radical departure would seem less tenable.

What trends do we need to investigate? Because we are here to get answers we must be pragmatic and not pedantic, so we will limit ourselves to examining those trends that may have predictive ability.

The questions considered will be:

What has been the rate of growth of the SMSA population and what will it be in the future?
Do SMSA's of varying size groups grow at different rates?
Is there a wide dispersion in growth rates among SMSA's in the same size group?
Do SMSA's tend to have a relatively stable rate of growth?
Is the rate of growth of SMSA's correlated with the area in which it lies?
Given the answers to the questions above, what growth patterns can be forecast?

What has the growth rate been for the total SMSA population and what will it be in the future?

Growth of the metropolitan population has been one of the most conspicuous features of the population movement of the United States during the first half of the 20th century. For all decades the SMSA population has grown at a more rapid rate than that of the Nation.

Table 1
Percentage Increase in SMSA,* and
Total National Population
for the decades 1910-1960

Decade	SMSA*	Total National Population
1910-20	33.8	14.9
1920-30	32.1	16.2
1930-40	9.3	7.2
1940-50	26.0	14.3
1950-60	29.6	18.9

* The SMSA population for all decades is that residing in the geographic area that was defined as SMSA in 1960.

It is observed in Table 1 that the SMSA population increase has been relatively constant for the last 5 decades (ranging from 26-33 per cent) with the exception of the depression decade. The out-of-trend population increase in the SMSA population during the 1930's, was the result of a low national increase and a restricted rural to urban migration. The differential growth rate of the SMSA and non-SMSA primarily explained by the marked migration from the latter to the former.

The growth trend of the total SMSA population indicated in Table 1, however, cannot be used to depict the average growth trend of the individual SMSA's because the base is changing; i.e., more cities are included in the end of the decade than in the beginning of the decade. When the data are adjusted to exclude the population of those SMSA's that were added during the decade, the growth rate is more uniform. Again, with the exception of the depression years, the average SMSA growth varied within a narrow range - from 21 to 26 per cent, as shown in Table 2.

Table 2

Percentage Increase in SMSA,* and
Total National Population
for the Decades 1910-1960

	Percentage Increase for Decade		
Decade	SMSA-2	Non-SMSA's	National Total
1910-20	24.4	9.0	14.9
1920-30	26.6	8.0	16.2
1930-40	8.1	6.4	7.2
1940-50	21.4	6.3	14.3
1950-60	24.5	11.3	18.9

* The SMSA population for all decades is that which resided in the geographic area defined as SMSA in 1960. It includes, however, only the increase in population in the SMSA's that meet the requirements for SMSA's in the beginning of each decade. Hereafter, this will be referred to as SMSA-2. Those cities that met the SMSA criterion only at the end of each decade are included as non-SMSA population.

The apparent consistency of the SMSA-2 population increase during these 4 decades is an illusion and cannot be used in prediction. First, the national population increase varied and the relative size of the source of migration (the non-SMSA population) varied. If the effect of these two factors is standardized by the conditions which prevailed during the 1950-60 decade, the growth of the SMSA-2 population would show a declining trend. See Table 3.

Table 3

Standardized SMSA-2 Population Increase
by Decades 1910-1960

Decade	Percentage Increase
1910-20	33.1
1920-30	29.4
1930-40	27.0
1940-50	26.3
1950-60	24.5

This decline in the rate of increase for the SMSA-2 population perforce must continue for the reason that the relative size of the non-SMSA is decreasing and hence one of the main sources of growth, i.e., migration from the non-SMSA, is becoming relatively smaller and will, therefore, contribute relatively less to the SMSA-2 growth. Table 4 demonstrates this.

Table 4

Trend in the Ratio of Non-SMSA Population
to SMSA-2 Population
by Decades 1910-1960

Decade	SMSA Population (in millions) at Beginning of Decade	Non-SMSA Population (in millions) at Beginning of Decade	Ratio of the (migration pool) Non-SMSA to SMSA Population
1910-20	35.3	56.7	1.61
1920-30	47.2	58.5	1.24
1930-40	62.3	60.5	.97
1940-50	68.1	63.6	.93
1950-60	85.8	64.9	.76

Given these past 50-year trends, (1) what will be the forecast in the total SMSA population, and (2) what will be the forecast increase in the growth of the SMSA-2 population? (A national population of 380,000,000 in 2010 will be assumed.) The total SMSA population which increased 215 per cent during the last 50 years, will increase 157 per cent to 300,000,000 the next 50 years. The decrease in the rate of increase will occur in spite of the fact that the national population is assumed to increase a little more rapidly in the next 50 years than it did in the previous 50 years. The explanation is that one of its primary sources of population increase, the non-SMSA pool, is becoming relatively smaller. The SMSA-2 population will witness a decline in the rate of increase from 24 per cent in 1950-60 to 17.8 per cent between 2000-10. To assume that the present rate of SMSA population increase will continue, as many mistakenly do, is tantamount to assuming a national population of approximately 500,000,000. Few predict a population this high. These growth rates (Table 5) are based on projections shown on Figure 1. Note the fairly consistent growth trends of the past 50 years for both the SMSA and non-SMSA population.

Table 5

Trends and Forecast of SMSA Population
by Decades 1910-2010
(Population in millions)

Year	Number of SMSAs	Total SMSA[1] Population	Per Cent Increase	Total Adjusted SMSA[2] Population	Per Cent Increase[3]
1910	91	35.3			
			33.8		24.4
1920	119	47.2		43.9	
			32.1		26.3
1930	144	62.3		59.6	
			9.3		8.1
1940	151	68.1		67.3	
			26.0		21.4
1950	176	85.8		82.7	
			29.6		24.5
1960	210	111.2		106.8	
2000		250.2		246.0	
			19.8		17.8
2010		300.0		295.0	

[1] Total SMSA population the decade indicated.

[2] Population of those SMSA's which qualified as SMSA's the preceding decade.

[3] The 24.4 per cent, for example, is derived from 43.9 ÷ 35.3.

The preceding analysis is not intended to be used to forecast an individual SMSA; it is only to establish a ceiling for the rate of increase of SMSA's, and furthermore, to remind us that the rate of increase of SMSA's must decrease if we assume any national population forecast short of approximately 500,000,000.

Before turning our attention to the individual metropolitan area, let's see if there are significant differential growth rates among various size SMSA's. Do smaller ones grow more rapidly than larger ones? Do these cities slow down as they get larger?

Is the rate of growth associated with size? An answer to this question can be approximated two ways. First, we can group cities into several size categories and see if the smaller ones grow at a different rate than the larger ones. This has obvious shortcomings because the only factor being held constant is size, and size is not the major determinant in the rate of growth. Because many use this technique, it is well to examine these trends. A better measure, because it would have greater predictive value, would be to determine if the individual SMSA's vary in rate of growth as they get larger. This, too, is difficult to ascertain because the growth potential varied among decades. For example, in the 1930 decade, the population of the country grew at less than half the rate of any of the other decades studies; whereas the recent decade witnessed the greatest absolute, as well as relative, growth. This obviously affects and is affected by the growth rate of SMSA's. An examination of the question is nevertheless worthwhile because it may lead us to "ball park" figures. If not, it is equally important to expose erroneous forecast methods.

The median growth rate is remarkably constant for the SMSA's in the four-size classes, between 100 thousand and 1.6 million. The average for the 5 decades ranged from 17.2 per cent to 19.6 per cent. See Table 6. There was greater variability, however, within a size class from one decade to another. Nevertheless, the range was not large. The cities under 100,000 and those over 1,600,000 grew at a slower rate. The reason for the lower rate of increase for the smallest group is that, compared to larger SMSA's, a disproportionately large part of their metropolitan area is rural; and therefore, a relatively larger part of their total population has been subjected to a historical downward trend. If the effect of this were eliminated, cities under 100,000 would grow at approximately 19 per cent also. These data suggest that size, within the limits mentioned, does not affect the rate of growth. The statement is equally true of individual cities. Cities between 100,000 and 800,000 do not decrease in the rate of growth as they get larger.

Knowledge of the average growth rate and the correlation of size and growth rate is useful but one cannot rest the forecasts on these. There are wide deviations from these averages. While it is true that one may miss the forecast on the total population of a group of cities less if he uses the average, there are measures which are more accurate for individual cities. Let's next examine the extent of the variation from the average.

Is there a wide dispersion in growth rates among SMSA's? There is an extreme range in the rate of change. Some more than doubled during a ten-year span, while others decreased. The smaller SMSA's have a greater disparity in the rate of growth than larger cities. Even the size group that had the least variability in the rate of growth during the 1950-60 decade - the 800,000 to 1,600,000 class - varied from a low of 15 per cent increase to a high of 53 per cent.

# POPULATION TRENDS and FORECASTS
for
SMSA, NON-SMSA and TOTAL U.S. POPULATION
1910—2010

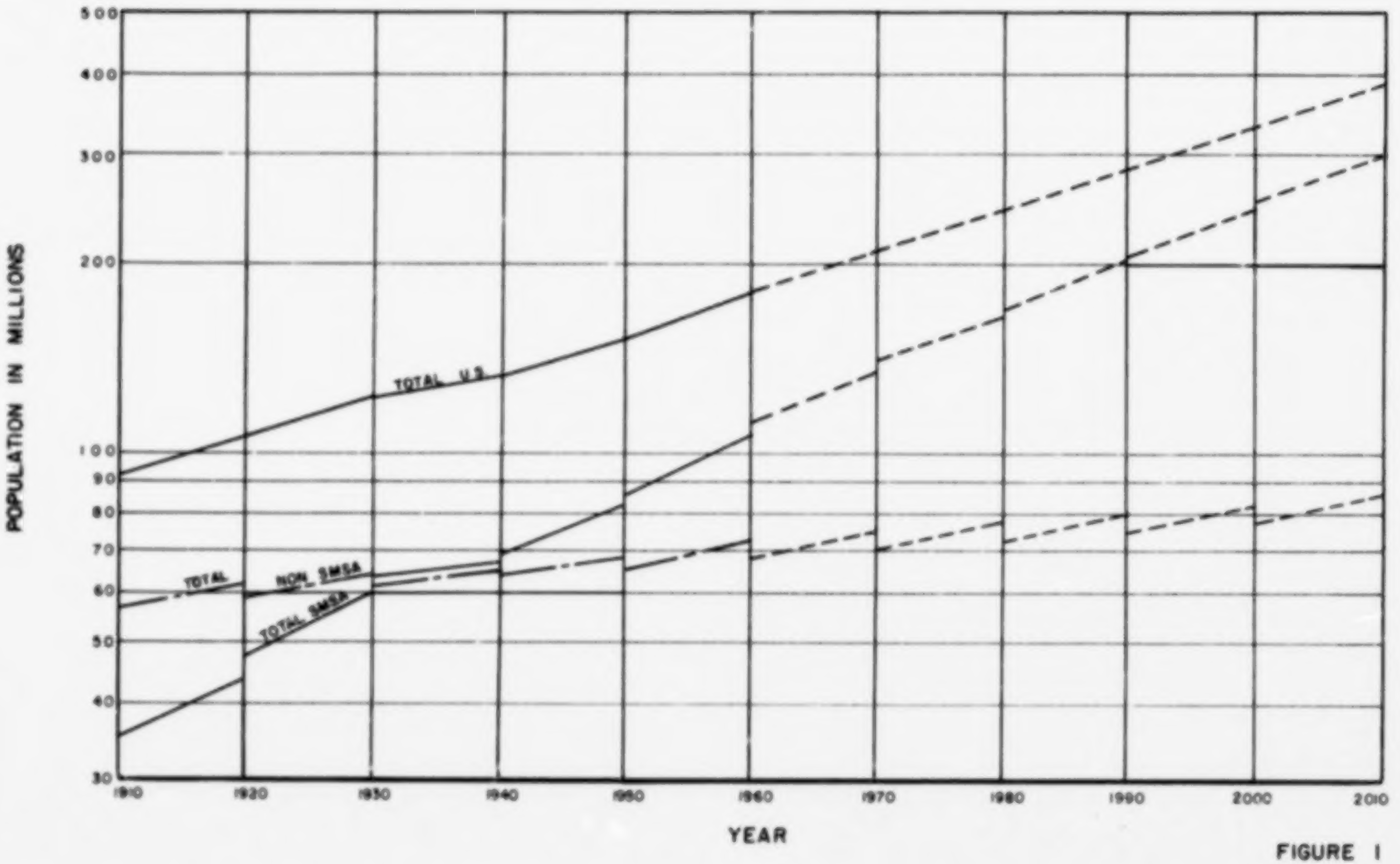

FIGURE 1

Table 6

Population Increases in SMSA's of Varying Size Classes
1910 - 1960

	Under 100,000	100-200,000	200-400,000	400-800,000	800-1,600,000	Over 1,600,000	Total SMSA Population
Number	15	32	23	15	2	4	91
1910	1,279,866	4,540,290	6,302,265	8,780,979	2,503,536	11,849,576	35,256,512
1920	1,528,089	5,901,813	7,693,545	11,601,712	2,926,421	14,224,524	43,876,104
Mean	19.4	30.0	22.1	32.1	16.9	20.0	24.4
Median	22.4	23.4	21.2	23.8	16.4	19.0	
Number	16	47	32	12	7	5	119
1920	1,351,379	6,603,106	9,122,690	6,819,983	7,288,751	15,984,513	47,170,422
1930	1,633,518	8,223,378	10,942,650	8,266,542	10,768,405	19,753,621	59,590,114
Mean	20.9	24.5	19.9	21.2	47.7	23.6	26.3
Median	15.3	18.2	18.3	20.6	33.5	16.0	
Number	23	51	37	19	7	7	144
1930	1,970,013	7,276,853	10,280,272	10,445,550	8,057,899	24,258,130	62,288,717
1940	2,117,498	8,125,941	11,163,637	11,262,716	8,549,984	26,095,463	67,315,239
Mean	7.5	11.7	8.6	7.8	6.1	7.6	8.1
Median	5.2	9.5	7.2	6.6	5.6	3.4	
Number	20	54	42	19	9	7	151
1940	1,708,770	7,775,723	11,736,553	10,436,693	10,350,174	26,095,463	68,103,376
1950	2,110,688	9,866,820	14,610,423	12,748,706	12,960,743	30,412,775	82,710,155
Mean	23.5	26.9	24.5	22.2	25.2	16.5	21.4
Median	16.8	22.4	19.8	21.5	17.4	13.3	
Number	18	62	47	28	12	9	176
1950	1,467,122	8,800,958	12,982,471	14,966,685	13,246,952	34,372,830	85,837,018
1960	1,748,442	11,163,348	16,271,351	19,715,530	16,726,103	41,218,740	106,842,514
Mean	19.2	26.8	25.3	31.7	26.3	19.9	24.5
Median	17.7	24.4	19.3	25.4	25.4	19.0	
Number						(new) 34	210
1960						4,405,190	111,248,704
Mean of above medians							
Excluding '30's	18.1	22.1	19.6	22.8	23.2	16.8	
Including '30's	15.5	19.6	17.2	19.6	19.6	14.1	

The difference in these rates is greater than is first apparent. If one were to project an SMSA of 1,000,000 population on the basis of these two rates compounded every decade, he would show a projection of 1,600,000 and 8,000,000. And remember, the other size groups vary more. See Table 7.

This is not to say, however, that no discernible pattern exists. These are the extreme variations in the rate of growth and there are obviously few SMSA's at either the upper or lower end of the scale. To show the variation between these extremes and to bring order to this mass of data, the rate of growth is tabulated for SMSA's by size groups and by relative rank in Table 7 for four previous decades. To show this dispersion, the percentile rank was computed. The 75th percentile, for example, indicates the percentage growth that above which 25 per cent and below which 75 per cent of the SMSA's experienced. The percentile growth rates for each SMSA size group were averaged for all decades to more nearly approximate the rate of growth over time. The 1930-40 decade was eliminated because it was atypical, while the other four decades had a relatively uniform national growth rate and one which coincides with the projected national growth rate. Variability in the growth rate between decades within the same percentile rank of a given SMSA size class exists, but is not great in the 25 to 75 percentile rank. For example, the SMSA (size class 200,000 to 400,000) in the 75th percentile growth rank increased between 28 per cent and 31 per cent for an average of 30 per cent. The median or 50th percentile increased from 18 to 21 per cent, or an average of 20 per cent, while the 25th percentile increased between 11 per cent to 18 per cent for an average of 14 per cent. Figure 2 shows the average of these percentile growth rates. Note the uniformity of the rates of growth for the 75th to 25th percentile rank for the cities between 100,000 to 1,600,000. As mentioned previously, the SMSA's under 100,000 are expected to approximate more closely the rate of increase of the other SMSA size groups in the near future. It is only the SMSA's over 1,600,000 that will continue to deviate from this pattern.

Of what predictive value is the above analysis? Simply this - it will give guidance to the upper and lower limit of a projection. One can test the "reasonableness" of a given SMSA attaining a specific forecast population given the trends of past SMSA's in various size groups and given the particular SMSA's past growth rate within these size classes. If a SMSA has been growing slower than average, say about at the 25th percentile rank, then one can see what population it would attain if it stayed at this relative position. Or if one made a forecast, one can backtrack and determine at what relative rank this SMSA would have to grow to reach this forecast and to see if this is "reasonable" in view of its past performance. One problem remains: Does an SMSA tend to grow at a relatively constant trend compared to other cities in its size group? To spot-check this, we will review the performance of the cities you gentlemen represent. New York and Chicago are omitted because there are too few SMSA's in this size category.

Table 7

Range in the Percentage Rate of Growth of SMSA's of Varying Size Groups for 1910-20, 1920-30, 1940-50, 1950-60

		Percentile								
	No.	Highest	90	75	67	50	33	25	10	Lowest
Under 100,000:										
1910-1920	15	51		25	23	22	13	12		1
1920-1930	16	56	49	38	24	15	10	9	0	-5
1940-1950	20	79	42	30	27	17	16	15	7	3
1950-1960	18	69	32	27	22	17	10	8	3	-7
Average		64	41	30	24	18	12	11	5	-2
100-200,000:										
1910-1920	32	164	60	41	33	23	17	13	9	1
1920-1930	47	92	68	31	29	18	11	9	-1	-7
1940-1950	54	78	55	33	28	22	18	14	3	-1
1950-1960	62	123	45	32	30	24	21	16	2	-3
Average		116	57	34	30	22	17	13	3	-2
200-400,000:										
1910-1920	23	37	33	28	27	21	19	18	12	7
1920-1930	32	45	38	29	26	18	14	12	4	-8
1940-1950	42	92	52	31	29	20	13	11	4	-15
1950-1960	47	120	47	30	25	19	16	14	4	-12
Average		73	43	30	27	20	16	14	6	-7
400-800,000:										
1910-1920	15	113		30	28	24	18	17		5
1920-1930	12	42		24	22	21	18	16		10
1940-1950	19	53	42	36	28	22	15	12	4	-11
1950-1960	28	86	79	40	35	25	21	18	11	-6
Average		73	60	32	28	23	18	16	7	0
800-1,600,000:										
1910-1920	2	20				16				13
1920-1930	7	133		58	40	33	26	20		15
1940-1950	9	53		28	22	17	15	14		13
1950-1960	12	53		32	29	25	22	20		15
Average		55*		32*	30	23	21	18		14
Over 1,600,000:										
1910-1920	4	26				19				17
1920-1930	5	31				16				15
1940-1950	7	50		23	17	13	9	8		6
1950-1960	9	53		22	20	19	14	10		6
Average		40		22	18	17	12	9		6*

* Atypical cases adjusted

Table 8

Percentile Growth Rank of Select SMSA's for Decades 1910-20, 1920-30, 1930-40, 1940-50, 1950-60

	1910-20	1920-30	1930-40	1940-50	1950-60
Atlanta	67	80	92	71	73
Austin	*	*	98	82	70
Cincinnati	10	45	45	34	11
Dallas	80	77	87	87	80
Denver	33	48	82	76	84
Houston	92	99	99	97	97
Kansas City	57	80	34	39	54
Salt Lake City	42	56	46	73	86
San Francisco-Oakland	77	50	64	94	72
Washington, D. C.	63	28	97	83	80

* Did not meet the requirement of a SMSA.

Table 8 indicates that some SMSA's grow at a relatively consistent trend compared to other SMSA's in their size group while others do not. However, the validity of a forecast within broad limits can be checked by these data. Atlanta, for example, fluctuated within the upper one-third of the fastest growing SMSA in its size-class during the last 5 decades. Austin has been experiencing a relatively decreasing rate of growth. Houston, on the other hand, has consistently been the fastest growing SMSA in its size group the last four decades.

These data establish rather broad boundary lines for projections. Atlanta has been hovering around the 75th percentile growth rate. The median growth rate would seem low, but likewise the 90th percentile would seem high. On the other hand, Cincinnati has never grown as fast as the median. It would seem from its past record, and in the absence of radically changed conditions, that to select a growth rate for Cincinnati that would be above average would not be tenable.

In order to make projections of the probable range of growth on the basis of the procedure just discussed, it will be necessary to project the percentile range in growth rate of the various SMSA-size categories. It is assumed that the decreasing rate of SMSA growth in each succeeding decade will influence all percentile growth rates in the same relative amount. These projected growth rates are tabulated in Table 9.

An example of the use of Table 9 to project a SMSA follows. Table 8 shows that Dallas SMSA fluctuated between the 77th and 87th percentile. What would be the range in the 2010 projection if one assumes the upper limit would be that paralleling the projected 90th percentile growth rate and the lower limit would parallel the 75th percentile?

RANGE IN PERCENTAGE GROWTH OF SMSA'S OF VARYING SIZE GROUPS

1910 – 1960

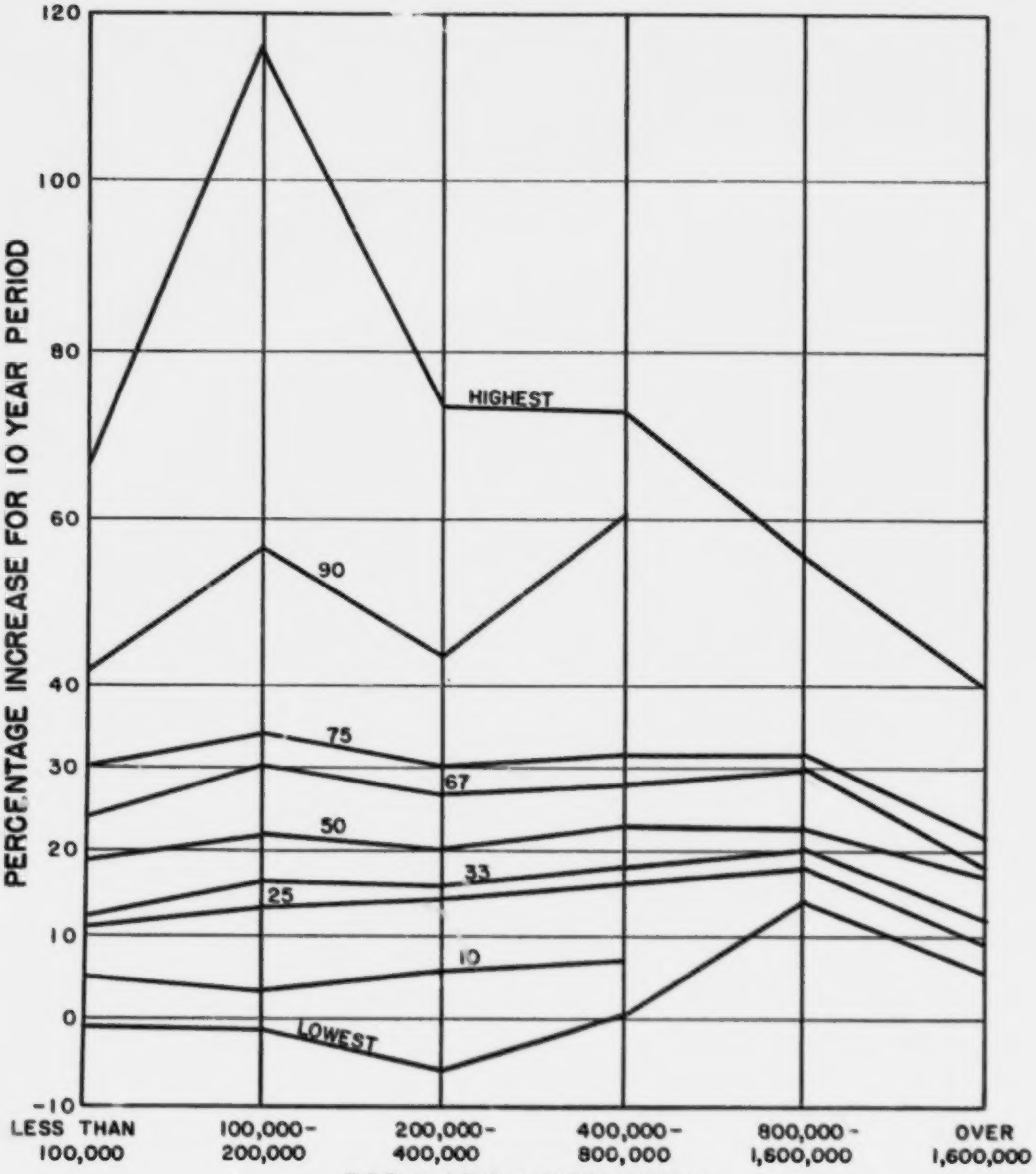

FIGURE 2

Table 9
Forecast Range in Percentage Growth Rates for SMSA's of Various Size Classes
1950-2010

	Percentile								
	Highest	90	75	67	50	33	25	10	Lowest
Under 100,000 to 800,000:									
1950-1960	75	50	32	29	23	18	15	5	0
1960-1970	70.8	47.3	30.2	27.4	21.7	17.0	14.2	4.7	0
1970-1980	66.7	44.5	28.5	25.8	20.5	16.0	13.4	4.4	0
1980-1990	62.6	41.8	26.7	24.3	19.2	15.1	12.5	4.2	0
1990-2000	58.5	39.0	25.0	22.7	18.0	14.1	11.7	3.9	0
2000-2010	54.4	36.3	23.2	21.1	16.7	13.1	10.9	3.6	0
800,000 to 1,600,000:									
1950-1960	55	40	32	29	23	20	18	16	14
1960-1970	52.0	37.8	30.2	27.4	21.7	18.9	17.0	15.1	13.2
1970-1980	49.0	35.6	28.5	25.8	20.5	17.8	16.0	14.2	12.5
1980-1990	45.9	33.4	26.7	24.3	19.2	16.7	15.1	13.4	11.7
1990-2000	42.9	31.2	25.0	22.7	18.0	15.6	14.1	12.5	11.0
2000-2010	39.9	29.0	23.2	21.1	16.7	14.5	13.1	11.6	10.2
Over 1,600,000:									
1950-1960	45	30	22	19	18	13	9	8	6
1960-1970	42.5	28.4	20.8	18.0	17.0	12.3	8.5	7.6	5.7
1970-1980	40.1	26.7	19.6	16.9	16.0	11.6	8.0	7.1	5.3
1980-1990	37.6	25.1	18.4	15.9	15.1	10.8	7.5	6.7	5.0
1990-2000	35.2	23.4	17.2	14.8	14.1	10.1	7.0	6.2	4.7
2000-2010	32.7	21.8	16.0	13.8	13.1	9.4	6.5	5.8	4.4

The mean associated with the above medians is 24.5 per cent.
The mean growth in 2010 is assumed to be 17.8 per cent.

The percentile growth rates therefore is reduced by 24.5/17.8 or 72.6 per cent by 2010. The intervening years were reduced by arithmetic progression.

Table 10

Projection of Dallas
(Using projected 90th percentile growth rate)

Year	Population	Growth Rate	Population	Year
1960	1,071,000	137.8	1,476,000	1970
1970	1,476,000	135.6	2,001,000	1980
1980	2,001,000	125.1	2,504,000	1990
1990	2,504,000	123.4	3,089,000	2000
2000	3,089,000	121.8	3,763,000	2010
	(Using projected 75th percentile growth rate)			
1960	1,071,000	130.2	1,394,000	1970
1970	1,394,000	128.5	1,792,000	1980
1980	1,792,000	118.4	2,122,000	1990
1990	2,122,000	117.2	2,486,000	2000
2000	2,486,000	116.0	2,884,000	2010

One enters the table with three arguments; SMSA size, percentile growth rate, and decade. In this table one finds that SMSA's ranging from 800,000 - 1,600,000 (Dallas was 1,071,000 in 1960) in the 1960-70 decade are predicted to grow 37.8 per cent during the decade (if they grow at the 90th percentile growth rate). During the following decade the rate is 35.6 per cent. By 1980 Dallas SMSA is over 1,600,000, so one drops down to the category "over 1,600,000" and uses the growth rates of 25.1 per cent, 23.4 per cent, and 21.8 per cent for the next three decades. The same is repeated for the 75th percentile growth rate. The calculations are illustrated in Table 10.

What are the basic assumptions behind this population forecast procedure? There are scores of factors influencing the competitive economic advantage or "pulling power" of an area. Although this method does not identify these factors or indicate which factors exert the greatest relative influence, the growth rates upon which the methodology is based represents the composite effect of all the factors influencing economics and hence population change. It likewise shows the relative total comparative advantage among the various metropolitan areas. The major assumption of this projection technique is that the relative "pulling power" of the SMSA in the future will be similar to that of the past.

What is the reliability of these projections? The Bureau of the Census states, "There is no approved body of knowledge which justifies confident predictions for 15 years or more into the future." This being the case, what claim to fame has this method? What accuracy does it purport to have? The writer devised this procedure in an attempt to establish limits within which a forecast would seem "reasonable". The validity cannot be checked, of course, but it can be compared to other techniques.

How do projections by this method compare with others? The RFF projection for the year 2000 was 2,950,000 (corrected to include the addition of 3 more counties to the Dallas SMSA) based upon the United States total of 380,000,000 in 2010, which is assumed here. The projection of Dallas SMSA by the Bureau of Census for 2000 (adjusted too for the same assumed national population) was approximately 2,860,000. The projections proposed by the writer indicate a low of 2,486,000 and a high of 3,089,000, for an average of 2,788,000. The difference is less than 6% between this method and RFF, and less than 3% between this method and Bureau of the Census in a 40-year span.

Another check is to work "backwards". A population as high as 9,000,000 has been forecast for Houston SMSA from a base of 1,236,704 in 1960. Is this "reasonable"? To attain this population growth in 50 years, Houston SMSA would have to increase 50 per cent every 10 years. Although this rate of increase had been attained in the 1950-60 decade by both Houston and Los Angeles, the fastest growing SMSA's in the two largest size categories (see Table 7), it seems unlikely that a growth rate of that magnitude can be sustained for reasons mentioned earlier. If Houston SMSA is assumed to continue to grow at the highest growth rate indicated on Table 9, a population forecast of 6,502,000 would seem more reasonable.

This population forecast methodology is intended to supplement or be supplemented by a thorough study of the resources and other growth factors of the study area.

Summary and Conclusions

1. There is no approved body of knowledge that justifies confident population predictions for 15 years or more into the future. Nevertheless, forecasts must be made. This paper summarizes the trends for Standard Metropolitan Statistical Areas during the last 50 years, and suggests limits of probable growth trends for each SMSA in the Nation.

2. Data of population trends of the last 50 years show these trends:

   a. The total SMSA population has been increasing at a relatively constant rate.
   b. Net migration flows from the non-SMSA to the SMSA; therefore, the SMSA is becoming a relatively larger part of the total population.
   c. The median growth rates and the deviations from the median of SMSA's between 100,000 and 1,600,000 show marked similarity.
   d. Although there is considerable variation in the rate of growth among SMSA's in the same size group, the relative variability in the growth rates of individual SMSA's is considerably less.

3. Past trends suggest that:

   a. The growth rate of the total SMSA population will decrease because the migration from the non-SMSA's will contribute relatively less in its growth in the future.
   b. Since many SMSA's grow at a relatively consistent trend in relation to the growth rate of other SMSA's in their size category, the growth rates for individual SMSA's can be projected.

4. The past rate of growth and the relative dispersion in the rate of growth is shown for all SMSA's of the Nation in the appendix. From these data, the forecaster may make a judgment as to the limits of the most probable future growth rate of a given SMSA. Table 9 summarizes the projected growth rates that can be used for projection.

APPENDIX

Population, Percentage Population Change, and Percentile Growth Rank of Standard Metropolitan Statistical Areas of the United States, 1910-1960

Note: The population for Standard Metropolitan Statistical Areas for all decades has been adjusted for changes in boundaries; that is, the population of 1950 and previous decades is that residing in the SMSA'S as defined in 1960. The first row of figures is the population, the second row is the percentage change in population for the decade, and the third row is the percentile growth rank. The figures in parentheses indicate that the SMSA did not meet the qualifications to be defined as SMSA in 1950. All 1960 data are preliminary population figures.

	1910		1920		1930		1940		1950		1960
Abilene, Texas									(85,517)	(39.4)	119,178
Akron, Ohio	108,253	164.2 98	286,065	20.3 52	344,131	-1.4 7	339,405	20.8 54	410,032	24.1 41	508,788
Albany, Georgia									(43,617)	(71.5)	74,787
Albany, Schenectady, Troy, New York	446,094	5.1 3	468,627	11.0 11	520,069	2.1 24	531,249	10.9 18	589,359	10.7 9	652,205
Albuquerque, New Mexico									145,673	78.6 96	260,162
Allentown, Bethlehem, Easton, Pa. & N. J.	289,686	19.7 41	346,664	12.9 27	391,516	1.3 23	396,673	10.4 20	437,824	12.1 13	490,660
Altoona, Pennsylvania	108,858	17.9 36	128,334	9.0 27	139,840	0.4 13	140,358	-0.6 1	139,514	-2.5 2	136,027
Amarillo, Texas							61,450	41.8 87	87,140	69.4 97	147,621
Ann Arbor, Michigan									134,606	27.8 57	172,016

	1910		1920		1930		1940		1950		1960
Asheville, North Carolina					97,937	11.0 80	108,755	14.4 25	124,403	2.4 10	127,367
Atlanta, Georgia	273,288	27.6 67	348,580	32.6 80	462,386	20.9 92	558,842	30.1 71	726,989	39.0 73	1,010,577
Atlantic City, New Jersey			83,914	48.8 91	124,823	-0.6 5	124,066	6.7 12	132,399	19.6 31	158,312
Augusta, Georgia - South Carolina			109,266	10.2 31	120,393	9.5 50	131,779	22.9 53	162,013	32.1 75	214,079
Austin, Texas					77,777	42.8 98	111,058	45.0 82	160,980	30.8 70	210,519
Bakersfield, California									(228,309)	(26.2)	288,127
Baltimore, Maryland	770,427	17.1 30	902,122	14.9 7	1,036,753	9.9 93	1,139,529	23.3 72	1,405,399	21.5 28	1,707,462
Baton Rouge, Louisiana									158,236	44.7 90	228,893
Bay City, Michigan									88,461	19.4 58	105,594

	1910		1920		1930		1940		1950		1960
Beaumont, Port Arthur, Texas									235,650	29.4 73	304,826
Billings, Montana									(55,875)	(39.6)	78,001
Binghamton, Endicott, New York			113,610	29.4 71	147,022	12.7 60	165,749	11.4 14	184,698	14.6 22	211,705
Birmingham, Alabama	226,476	36.9 98	310,054	39.2 92	431,493	6.6 50	459,930	21.5 50	558,928	12.6 16	629,248
Boston, Massachusetts	1,602,023	16.7 12	1,868,859	16.0 50	2,168,566	3.4 50	2,242,978	7.5 21	2,410,572	6.5 6	2,566,732
Bridgeport, Connecticut	125,717	51.8 86	190,803	10.5 33	210,764	6.9 47	225,268	21.5 58	273,723	21.7 52	333,042
Brockton, Massachusetts	94,866	12.3 30	106,526	1.1 14	107,668	-1.0 3	106,631	12.3 19	119,728	24.4 49	148,988
Brownsville, Harlingen, San Benito, Texas									(125,170)	(19.8)	149,901
Buffalo, New York	621,021	21.3 43	753,393	21.0 54	911,737	5.1 36	958,487	13.6 6	1,089,230	19.5 20	1,301,604

	1910		1920		1930		1940		1950		1960
Canton, Ohio	122,987	44.1 80	177,218	25.1 61	221,784	5.9 45	234,887	20.6 51	283.194	19.3 50	337,984
Cedar Rapids, Iowa					82,336	8.3 67	89,142	17.0 52	104,274	29.6 67	135,192
Champaign-Urbana, Illinois									(106,100)	(23.3)	130,813
Charleston, South Carolina	88,594	22.4 57	108,450	-6.8 1	101,050	19.8 83	121,105	36.1 81	164,856	27.2 56	209,757
Charleston, West Virginia					157,667	24.1 95	195,619	22.5 51	239,629	4.4 10	250,284
Charlotte, North Carolina					127,971	18.6 81	151,826	29.8 71	197,052	37.5 86	270,966
Chattanooga, Tennessee - Georgia			139,324	33.3 82	185,703	13.9 75	211,502	16.5 42	246,453	13.3 22	279,314
Chicago, Illinois	2,702,465	25.6 87	3,394,996	31.1 90	4,449,646	2.7 21	4,569,643	13.3 50	5,177,868	19.2 61	6,171,517
Cincinnati, Ohio - Kentucky	590,456	6.5 10	628,999	20.2 45	756,281	4.1 45	787,044	14.9 34	904,402	18.1 11	1,067,669

	1910		1920		1930		1940		1950		1960
Cleveland, Ohio	660,352	47.2 83	972,162	27.9 36	1,243,129	1.9 7	1,267,270	15.6 39	1,465,511	21.9 37	1,786,740
Colorado Springs, Colorado									(74,523)	(91.4)	142,643
Columbia, South Carolina					124,161	13.4 74	140,837	32.7 75	186,844	38.1 88	257,971
Columbus, Georgia - Alabama							126,407	34.9 79	170,541	26.7 54	216,155
Columbus, Ohio	221,567	28.2 72	283,951	27.2 73	361,055	7.7 58	388,712	29.5 68	503,410	35.1 66	680,183
Corpus Christi, Texas							92,661	78.6 97	165,471	32.4 77	219,028
Dallas, Texas	269,656	30.2 80	351,215	30.6 77	458,629	14.9 87	527,145	41.0 87	743,501	44.0 80	1,071,003
Davenport, Rock Island, Moline, Iowa - Illinois			166,249	5.6 18	175,523	12.8 62	198,071	18.3 36	234,256	14.2 24	267,414
Dayton, Ohio	238,543	21.2 50	289,181	23.8 64	358,041	7.2 50	383,975	35.1 80	518,642	32.9 62	689,339

	1910		1920		1930		1940		1950		1960
Decatur, Illinois					81,731	3.6 37	84,693	16.7 47	98,853	18.8 53	117,470
Denver, Colorado	277,097	19.4 33	330,948	16.3 48	385,019	15.6 82	445,206	37.5 76	612,128	51.2 84	925,569
Des Moines, Iowa	110,438	39.5 73	154,029	12.2 37	172,837	13.3 70	195,835	15.4 27	226,010	17.2 44	264,895
Detroit, Michigan	613,773	112.7 97	1,305,798	66.7 79	2,177,343	9.2 64	2,377,329	26.9 79	3,016,197	24.1 83	3,743,447
Dubuque, Iowa									71,337	11.8 36	79,740
Duluth, Superior, Minnesota - Wisconsin	210,696	21.6 54	256,162	-1.9 5	251,179	1.1 18	254,036	-0.5 8	252,777	7.9 16	272,674
Durham, North Carolina					67,196	19.4 89	80,244	26.7 67	101,639	11.3 19	113,083
El Paso, Texas			101,877	29.2 69	131,597	-0.4 7	131,067	48.8 84	194,968	59.9 94	311,759
Erie, Pennsylvania	115,517	32.9 67	153,536	14.2 44	175,277	3.2 23	180,889	21.3 45	219,388	12.8 20	247,538

	1910		1920		1930		1940		1950		1960
Eugene, Oregon									(125,776)	(27.8)	160,742
Evansville, Indiana - Kentucky	106,790	12.3 20	119,902	16.4 46	139,615	13.0 64	157,803	21.1 44	191,137	2.9 12	196,634
Fall River, Massachusetts - Rhode Island	131,031	1.8 5	133,348	0.2 12	133,599	1.2 17	135,137	1.6 5	137,298	0.1 6	137,420
Fargo, Moorhead, North Dakota - Minnesota									(89,240)	(17.6)	104,983
Fitchburg, Leominster, Massachusetts									(74.943)	(9.4)	81,951
Flint, Michigan			125,668	68.4 90	211,641	7.7 55	227,944	18.9 49	270,963	36.7 84	370,303
Fort Lauderdale, Hollywood, Florida									(83,933)	(292.5)	329,406
Fort Smith, Arkansas									64,202	3.5 14	66,454
Ft. Wayne, Indiana	93,386	22.4 50	114,303	28.4 65	146,743	5.7 36	155,084	18.5 38	183,722	25.7 52	230,963
Fort Worth, Texas	143,032	32.9 70	190,086	21.5 54	230,870	10.8 69	255,905	53.4 92	392,643	42.1 88	557,864

	1910		1920		1930		1940		1950		1960
Fresno, California					144,379	23.7 93	178,565	54.9 90	276,515	30.5 78	360,962
Gadsden, Alabama									93,892	2.3 8	96,048
Galveston, Texas City, Texas					64,401	26.0 93	81,173	39.3 82	113,066	22.2 41	138,156
Gary, Hammond, East Chicago, Indiana			180,213	57.7 88	284,131	13.0 77	321,031	27.2 65	408,228	40.1 77	571,799
Grand Rapids, Michigan	159,145	15.0 27	183,041	31.4 78	240,511	2.4 28	246,338	17.0 44	288,292	25.1 67	360,574
Great Falls, Montana									(53,027)	(38.0)	73,203
Green Bay, Wisconsin									98,314	26.7 75	124,536
Greensboro, High Point North Carolina					133,010	15.7 77	153,916	24.1 55	191,057	28.5 60	245,578
Greenville, South Carolina									168,152	24.4 51	209,227
Hamilton, Middletown, Ohio					114,084	5.4 32	120,249	22.4 49	147,203	34.6 83	198,166

	1910		1920		1930		1940		1950		1960
Harrisburg, Pennsylvania	190,631	11.0 14	211,694	10.3 17	233,467	8.0 61	252,216	15.9 39	292,241	17.3 48	342,664
Hartford, Connecticut	172,927	31.8 64	227,963	27.0 70	289,561	8.2 64	313,192	29.8 70	406,534	28.6 59	522,735
Houston, Texas	115,693	61.3 92	186,667	92.5 99	359,328	47.2 99	528,961	52.5 97	806,701	53.3 97	1,236,704
Huntington, Ashland, W. Virginia - Kentucky-Oklahoma			160,579	31.0 73	210,382	7.3 53	225,668	8.9 15	245,795	2.8 7	252,780
Huntsville, Alabama									(72,903)	(60.0)	116,612
Indianapolis, Indiana	263,661	32.0 85	348,061	21.4 58	422,666	9.1 71	460,926	19.7 45	551,777	25.1 48	690,162
Jackson, Michigan					92,304	0.9 15	93,108	15.9 32	107,925	21.3 38	130,948
Jackson, Mississippi							107,273	32.5 73	142,164	31.2 72	186,574
Jacksonville, Florida	75,163	51.1 97	113,540	37.0 84	155,503	35.1 97	210,143	44.7 85	304,029	47.4 90	448,272
Jersey City, New Jersey	537,231	17.1 23	629,154	9.8 2	690,730	-5.6 3	652,040	-0.7 8	647,437	-6.2 2	607,250

	1910		1920		1930		1940		1950		1960
Johnstown, Pennsylvania	233,848	19.7 37	279,951	1.4 8	283,910	5.1 39	298,416	-2.4 6	291,354	-4.0 5	279,662
Kalamazoo, Michigan					91,368	9.5 76	100,085	26.6 60	126,707	33.5 81	169,151
Kansas City, Missouri - Kansas	422,180	25.3 57	528,833	25.9 80	665,655	3.2 34	686,643	18.6 39	814,357	27.0 54	1,034,150
Kenosha, Wisconsin					63,277	0.4 11	63,505	18.5 57	75,238	32.4 92	99,609
Knoxville, Tennessee			160,024	31.0 76	209,613	17.4 91	246,088	37.0 82	337,105	8.2 18	364,665
Lake Charles, Louisiana									(89,635)	(58.8)	142,307
Lancaster, Pennsylvania			173,797	13.3 39	196,882	7.9 42	212,504	10.5 25	234,717	16.7 41	273,862
Lansing, Michigan			134,041	28.7 67	172,489	11.0 52	191,411	27.6 64	244,159	22.6 54	299,386
Laredo, Texas									56.141	15.5 42	64,857

	1910		1920		1930		1940		1950		1960
Las Vegas, Nevada									(48,289)	(159.8)	125,466
Lawrence, Haverhill, Massachusetts - New Hampshire	159,828	15.3 30	184,212	-3.2 5	178,230	0.1 9	178,404	2.3 6	182,442	3.4 14	188,663
Lawton, Oklahoma									(55,165)	(61.9)	89,320
Lewiston, Auburn, Maine									(68,426)	(2.3)	69,967
Lexington, Kentucky									100,746	28.8 62	129,722
Lima, Ohio									88,183	16.6 47	102,785
Lincoln, Nebraska			85,902	16.8 59	100,324	0.3 11	100,585	19.0 42	119,742	29.0 65	154,474
Little Rock, North Little Rock, Arkansas			109,464	25.8 63	137,727	13.3 72	156,085	26.0 58	196,685	21.7 40	239,460
Lorain, Elyria, Ohio									148,162	45.7 91	215,822
Los Angeles, Long Beach, California	538,567	85.3 90	997,830	133.2 93	2,327,166	25.3 93	2,916,403	49.8 93	4,367,911	52.7 94	6,668,975

	1910		1920		1930		1940		1950		1960
Louisville, Kentucky - Indiana	323,473	7.1 2	346,411	21.5 61	420,769	7.3 61	451,473	27.8 66	576,900	24.6 45	718,685
Lowell, Massachusetts	122,133	8.8 8	132,861	-4.4 3	126,991	4.4 26	132,633	2.5 8	135,987	15.5 23	157,083
Lubbock, Texas									101,048	51.6 93	153,140
Lynchburg, Virginia									(96,936)	(13.6)	110,108
Macon, Georgia			93,268	-5.3 3	88,322	7.7 63	95,086	42.0 92	135,043	32.5 78	178,917
Madison, Wisconsin					112,737	15.9 79	130,660	29.6 69	169,357	30.8 69	221,595
Manchester, New Hampshire	72,642	11.2 17	80,775	-0.1 9	80,673	1.6 24	81,932	7.9 12	88,370	6.2 19	93,889
Memphis, Tennessee	191,430	16.6 33	223,216	37.3 89	306,482	16.9 88	358,250	34.7 77	482,393	28.5 55	619,722
Meriden, Connecticut									(44,088)	(15.6)	50,966
Miami, Florida					142,955	87.3 99	267,739	84.9 96	495,084	86.2 98	921,625

	1910		1920		1930		1940		1950		1960
Midland, Texas									(25,785)	(161.9)	67,540
Milwaukee, Wisconsin	470,287	23.8 50	582,061	33.6 89	777,621	6.7 55	829,629	15.3 28	956,948	23.8 45	1,184,806
Minneapolis, St. Paul, Minnesota	620,837	17.3 37	728,327	21.1 63	882,266	9.6 79	967,367	19.0 61	1,151,053	28.1 63	1,474,149
Mobile, Alabama	80,854	23.8 70	100,117	18.2 50	118,363	19.9 87	141,974	62.8 95	231,105	35.3 80	312,771
Monroe, Louisiana									(74,713)	(37.7)	102,889
Montgomery, Alabama					98,671	16.0 85	114,420	21.5 47	138,965	21.3 36	168,539
Muncie, Indiana									90,252	22.1 69	110,239
Muskegon, Muskegon Heights, Michigan									(121,545)	(22.5)	148,950
Nashville, Tennessee	149,478	12.3 23	167,815	32.8 80	222,854	15.4 80	257,267	25.1 63	321,758	22.6 56	394,338
Newark, New Jersey	727,787	28.5 70	934,940	33.6 64	1,249,167	3.4 21	1,291,416	13.7 17	1,468,458	14.6 2	1,682,882

	1910		1920		1930		1940		1950		1960
New Bedford, Massachusetts	110,537	27.2 58	140,641	-0.8 10	139,557	-1.1 1	138,073	2.8 10	141,984	0.2 7	142,257
New Britain, Connecticut			76,168	16.3 53	88,550	2.2 28	90,499	15.2 17	104,251	23.4 46	128,642
New Haven, Connecticut	164,702	23.8 52	203,850	14.0 42	232,327	5.1 42	244,294	10.4 23	269,715	14.5 27	308,786
New Orleans, Louisiana	362,599	14.1 20	413,750	22.1 71	505,306	9.3 76	552,244	24.1 61	685,405	25.7 52	861,299
Newport News, Hampton, Virginia									(154,977)	(43.9)	223,029
New York, New York	5,276,879	18.4 37	6,246,398	27.7 70	7,975,100	9.2 79	8,706,917	9.8 36	9,555,943	11.0 28	10,602,382
Norfolk, Portsmouth, Virginia	164,912	50.9 83	248,872	-7.7 2	229,635	12.8 74	258,927	72.3 94	446,200	21.4 34	541,494
Norwalk, Connecticut									(65,685)	(46.8)	96,397
Odessa, Texas									(42,102)	(112.7)	89,542

	1910		1920		1930		1940		1950		1960
Ogden, Utah									83,319	31.7 86	109,741
Oklahoma City, Oklahoma	127,576	23.8 55	157,984	73.9 93	274,801	8.9 66	299,216	31.2 75	392,439	29.6 76	508,581
Omaha, Nebraska - Iowa	233,652	17.9 28	275,444	13.7 33	313,272	3.8 34	325,153	12.7 32	366,395	24.5 63	456,164
Orlando, Florida									141,833	123.3 99	316,772
Paterson, Clifton, Passaic, New Jersey	353,904	32.8 89	469,877	42.0 97	667,106	7.8 66	718,999	21.9 55	876,232	35.1 89	1,183,514
Pensacola, Florida									(131,260)	(54.0)	202,140
Peoria, Illinois	134,282	11.9 17	150,250	24.7 59	187,426	13.0 66	211,736	18.3 46	250,512	14.6 29	287,115
Philadelphia, Pennsylvania - New Jersey	2,268,209	19.7 62	2,714,271	15.6 30	3,137,040	2.0 7	3,199,637	14.7 64	3,671,048	17.2 39	4,301,283
Phoenix, Arizona							186,193	78.2 99	331,770	98.2 97	657,688
Pittsburg, Pennsylvania	1,471,800	19.6 *	1,759,989	15.0 10	2,023,269	2.9 36	2,082,556	6.3 7	2,213,236	8.1 17	2,392,086

	1910		1920		1930		1940		1950		1960
Pittsfield, Massachusetts									66,567	9.7 31	73,049
Portland, Maine	77,668	17.2 43	91,055	9.7 28	99,874	6.7 54	106,569	12.5 21	119,942	-0.2 4	119,677
Portland, Oregon	303,829	22.7 59	372,777	35.5 86	505,037	-0.7 13	501,275	40.6 82	704,829	16.2 23	818,776
Providence, Rhode Island	542,591	8.4 17	588,090	15.2 20	677,195	2.7 29	695,253	9.3 13	760,202	6.6 5	810,145
Provo, Orem, Utah									(81,912)	(30.4)	106,777
Pueblo, Colorado					66,038	4.3 46	68,870	31.0 77	90,188	30.3 81	117,547
Racine, Wisconsin			78,961	14.3 47	90,217	4.2 41	94,047	16.5 37	109,585	28.4 59	140,745
Raleigh, North Carolina									136,450	23.7 48	168,835
Reading, Pennsylvania	183,222	9.6 11	200,854	15.4 45	231,717	4.4 36	241,884	5.7 11	255,740	7.4 14	274,638
Reno, Nevada									(50,205)	(66.7)	83,700

	1910		1920		1930		1940		1950		1960
Richmond, Virginia	172,364	22.5 45	211,135	13.3 30	239,288	11.2 72	266,185	23.2 61	328,050	23.9 61	406,601
Roanoke, Virginia			73,237	42.7 78	104,495	7.4 40	112,184	18.9 40	133,407	18.4 28	157,977
Rochester, New York	283,212	24.3 63	352,034	20.4 55	423,881	3.4 39	438,230	11.3 24	487,632	19.5 27	582,777
Rockford, Illinois			90,929	29.1 72	117,373	3.2 25	121,178	25.8 56	152,385	37.0 85	208,701
Sacramento, California			91,029	56.0 97	141,999	20.0 89	170,33	62.7 94	277,140	80.5 95	500,204
Saginaw, Michigan	89,290	12.3 23	100,286	20.4 52	120,717	8.1 44	130,468	17.7 32	153,515	23.3 44	189,237
St. Joseph, Missouri	93,020	0.7 3	93,684	5.3 16	98,633	-4.6 2	94,067	2.9 2	96,826	-7.2 3	89,897
St. Louis, Missouri - Illinois	1,031,736	13.1 *	1,166,432	18.9 21	1,387,075	5.6 50	1,464,111	17.4 50	1,719,288	19.0 50	2,046,477
Salt Lake City, Utah	131,426	21.2 42	159,282	21.9 56	194,102	9.0 46	211,623	29.9 73	274,895	38.9 86	381,961

	1910		1920		1930		1940		1950		1960
San Angelo, Texas									58,929	7.6 25	63,415
San Antonio, Texas	119,676	68.9 95	202,096	44.7 98	292,533	15.6 85	338,176	48.0 87	500,460	36.4 70	682,481
San Bernardino, Riverside, Ontario, California									451,688	77.3 87	800,865
San Diego, California			112,248	86.8 97	209,659	38.0 96	289,348	92.4 99	556,808	79.7 91	1,000,856
San Francisco, Oakland, California	773,975	30.4 77	1,009,467	33.5 50	1,347,772	8.5 64	1,461,804	53.3 94	2,240,767	21.6 72	2,725,841
San Jose, California					145,118	20.6 91	174,949	66.1 97	290,547	119.6 99	638,054
Santa Barbara, California									(98,220)	(70.9)	167,883
Savannah, Georgia	79,690	25.5 83	100,032	5.4 16	105,431	11.9 56	117,970	28.4 68	151,481	23.1 43	186,424
Scranton, Pennsylvania	259,570	10.3 7	286,311	8.4 14	310,397	-3.0 1	301,243	-14.6 1	257,396	-9.4 3	233,271

	1910		1920		1930		1940		1950		1960
Seattle, Washington	343,847		456,963		542,378		593,734		844,572		1,098,741
		32.9		18.7		9.5		42.2		30.1	
		93		37		82		92		71	
Shreveport, Louisiana					153,058		183,365		216,686		280,086
						19.8		18.2		29.3	
						85		34		71	
Sioux City, Iowa			92,171		101,669		103,627		103,917		107,863
				10.3		1.9		0.3		3.8	
				34		19		3		15	
Sioux Falls, South Dakota									70,910		85,951
										21.2	
										64	
South Bend, Indiana	84,312		103,304		160,033		161,823		205,058		237,874
		22.5		54.9		1.1		26.7		16.0	
		63		86		15		62		37	
Spokane, Washington	139,404		141,289		150,477		164,652		221,561		277,261
		1.4		6.5		9.4		34.6		25.1	
		2		20		48		77		65	
Springfield, Illinois	91,024		100,26		111,733		117,912		131,484		146,096
		10.1		11.4		5.5		11.5		11.1	
		10		35		34		18		17	
Springfield, Missouri					82,929		90,541		104,823		125,376
						9.2		15.8		19.6	
						72		27		30	
Springfield, Ohio			80,728		90,936		95,647		111,661		130,701
				12.6		5.2		16.7		17.1	
				41		50		42		27	

	1910		1920		1930		1940		1950		1960
Springfield, Chicopee, Holyoke, Massachusetts	263,147	28.5 76	338,033	11.4 23	376,699	-1.3 9	371,972	11.2 27	413,494	15.3 20	476,588
Stamford, Connecticut									134,896	31.4 73	177,305
Steubenville, Weirton, Ohio - West Virginia									(157,787)	(6.7)	168,293
Stockton, California							134,207	49.6 86	200,750	23.8 59	248,622
Syracuse, New York	311,251	13.1 11	352,045	13.9 39	401,041	1.2 18	405,981	14.6 29	465,114	20.9 30	562,362
Tacoma, Washington	120,812	19.3 39	144,127	13.7 41	163,842	11.1 54	182,081	51.5 88	275,876	16.2 39	320,438
Tampa, St. Petersburg, Florida			116,522	85.1 95	215,668	26.1 93	272,000	50.4 89	409,143	85.7 95	759,780
Terre Haute, Indiana	87,930	14.0 37	100,212	-1.3 7	98,861	0.9 20	99,709	5.5 7	105,160	2.4 9	107,668
Texarkana, Texas-Arkansas									(94,580)	(-3.6)	91,231

	1910		1920		1930		1940		1950		1960
Toledo, Ohio	192,728	43.1 77	275,721	26.1 67	347,709	1.0 15	344,333	14.9 37	395,551	14.9 31	454,472
Topeka, Kansas			69,159	23.2 66	85,200	7.1 59	91,247	15.5 22	105,418	33.1 80	140,355
Trenton, New Jersey	125,657	27.2 61	159,881	17.1 48	187,143	5.4 30	197,318	16.5 31	229,781	15.7 35	265,766
Tucson, Arizona									141,216	85.1 98	261,428
Tulsa, Oklahoma			208,039	43.7 95	299,023	-2.9 4	290,368	12.9 33	327,900	26.0 69	413,018
Tuscaloosa, Alabama									(94,092)	(15.4)	108,613
Tyler, Texas									(74,701)	(15.4)	86,188
Utica, Rome, New York	210,513	17.7 24	247,795	6.0 11	262,769	0.1 12	263,163	8.0 13	284,262	15.5 33	328,255
Waco, Texas					98,682	3.3 33	101,898	27.8 66	130,194	13.9 20	148,336
Washington, D. C. - Maryland-Virginia	445,401	28.4 63	571,090	17.5 28	672,198	44.4 97	970,561	50.8 83	1,464,089	34.4 80	1,967,682

	1910		1920		1930		1940		1950		1960
Waterbury, Connecticut	98,332	25.4 77	123,309	9.1 29	134,505	3.2 21	138,779	11.4 16	154,656	16.3 25	179,902
Waterloo, Iowa							79,946	25.6 62	100,448	21.0 33	121,567
West Palm Beach, Florida									(114,688)	(95.8)	224,537
Wheeling, West Virginia-Ohio			189,766	8.9 24	206,627	1.1 20	208,918	-6.0 4	196,305	-3.5 1	189,490
Wichita, Kansas	73,095	26.2 90	92,234	47.8 84	136,330	5.1 28	143,311	55.1 92	222,290	56.3 93	347,406
Wichita Falls, Texas			78,165	7.6 22	84,100	-3.4 7	81,203	29.7 72	105,309	21.2 35	127,654
Wilkes-Barre, Hazleton, Pennsylvania	343,186	13.9 15	390,991	13.8 36	445,109	-0.8 8	441,518	-11.2 3	392,241	-11.9 1	345,695
Wilmington, Delaware - New Jersey	150,187	23.1 48	184,811	7.1 22	197,866	12.1 58	221,836	21.0 56	268,387	35.3 82	363,253
Winton-Salem, North Carolina					111,681	13.2 68	126,475	15.5 29	146,135	28.8 64	188,229
Worcester, Massachusetts	205,564	19.8 46	246,347	10.7 20	272,704	1.4 26	276,453	9.6 18	303,037	6.4 12	322,438

	1910		1920		1930		1940		1950		1960
York, Pennsylvania					167,135	6.5 38	178,022	13.9 23	202,737	17.2 46	237,630
Youngstown, Ohio	168,917	60.0 89	270,230	32.9 83	359,205	3.7 31	372,566	11.8 30	416,544	21.8 38	507,557

DISCUSSION

James J. Flannery
Economist, Water Resources Planning Section, Technical Services Branch, Division of Water Supply and Pollution Control, Department of Health, Education, and Welfare, Washington, D. C.

The author is basically concerned with the future demand for water to be required (presumably through municipal sources and facilities) in the year 2010, which, he recognizes will be a function of the number of people and their activities. He recognizes too, that this area of prediction is one on which older and wiser heads have tread very softly, quoting that anything beyond 20 years hence is little more than a mathematical exercise. Then after pointing out some of the pitfalls of his assumptions he fearlessly proceeds with one such exercise - presumably because somebody has to do it.

His approach is not unreasonable, but one could wish for better backup on some of his figures and clearer statement of the derivation of his assumptions.

Essentially his method is to look at the per cent increase in growth of SMSA's over each 10-year period since 1910. He has devised a rather ingenious way of accounting for additional SMSA's as time passes, and finds that in each 10-year period except the 30's, areas designated as SMSA's increase their population approximately 24 per cent. However, he then proceeds to state that by 2010 this rate of increase will have declined to 17.8 per cent each ten years, but neglects to document his figure or state how he derives it.

The author does say the rate of growth of SMSA's will have to decrease because the non-SMSA migration pool will continue to become relatively smaller. He seems to carry this burden of thought throughout his exposition. He seems to give the false impression that the increase in population of SMSA's has been due entirely to migration, and to overlook the higher fertility rates of urban areas.

It is true that the non-SMSA population of the country has become relatively smaller over the years, but it is also true that in spite of what migration may have come from them, the absolute number has increased each ten years. Thus it seems that the projected decline in growth rates of SMSA's should not be so strongly predicated on the lack of migration alone.

To ascertain whether a pattern exists regarding growth in SMSA's of different sizes, the author has grouped them in doubling sizes of 1, 2, 4, 800,000 etc., then determined the rate of growth of each within its own group, and ranked these percentages from low to high and determined the percentiles. Thus in Table 7, there were 32 SMSA's of 100-200,000 population for the decade 1910-1920 (Note: He does not state whether these were for the beginning or end of the decade) whose per cent growth in the decade ranged from 1 per cent to 164 per cent. Of these, one-third increased 17 per cent or less, half (median) increased 23 per cent or less, and three-fourths of them increased 41 per cent or less. He does this for each of the decades and gets an average for the group; and repeats for each of the six groups. These averages are plotted in Figure 2.

The author then uses these figures and his judgment to arrive at the baselines for Table 9 and neatly, arithmetically, reduces them to an assumed mean growth figure for 2010, but never explains how the 2010 figure was derived.

GENERAL DISCUSSION

THOMAN: I have a question. You are not proposing this technique as a substitute for the resource base forecasting?

TORGET: No. As I pointed out - with the resources approach, you have certainly a great deal more validity in the conclusion one reaches, and it can be substantiated. The only point is, that it's not quite as infallible as it seems on the face of it. Even if you use it, it is just another check on where you might be placing this city. If the city has been hobbling along in the bottom 10% and it seems to have resources, if you come up to where it pushes this city in the upper 10% instead of the lower 10%, you need to take another good look at the resources and the extent to which you assume these will be developed. So it's to be a sort of a secondary check after doing the export base theory, or the resources approach.

WEISER: I wonder to what extent you have attempted to relate regional groups to these various cities. I raise this question because I feel that there is some kind of a pattern of reaching a kind of saturation point, in certain regions, so that maybe this might break down in a certain area where another region with a wide-open development potential would keep on continuing at the same rate

TORGET: That's a good point. In fact, that was brought out by everyone who read the paper, namely, "Could this be modified or adjusted to account for regional differences?" I do feel that the regional influence is in there to the extent that the ones in the Northeast show that they are already in the lower group of the growth rates, and secondly, I'm not too impressed by the regional influences, although they should certainly be considered. I say this for this reason: that if the regional influence is a causal factor, why shouldn't it work in about the same direction for all the cities in the area? And you find a great deal of dispersion within cities - I mean between metropolitan areas - within the region. For example, St. Joe, Missouri, has been going sideways for 50 years, or slightly down. It hasn't fluctuated at all. Just a very slow affair, and still there are many others in that region that have been increasing at near the top of the heap. Now, let's pause and think of this. What is the causal effect of the regional shift in that area, if it has caused some to go up and some to go down? Jerome Pickard said that the growth rate of the region is a reflection of the growth rate in the metropolitan area more than the other way around. It is certainly one that should have been spelled out more and more, and investigated to see what the differences have been among the regions, but I didn't do that - I didn't have time.

FLANNERY: I'm proxy for Sted Green to present his comments on this paper. Basically Mr. Green and Mr. Jenkins were not at all critical of this paper but - they did not give this the diluted endorsement that

Roger Pryor did. They endorsed it strongly, but they had some questions as to some features. For instance, in the 17.8% growth rate by 2010, they wanted to know what kind of an assumption was behind this, granting that there would be a smaller pool of migrators from the rural areas into the SMSA. What is the growth rate? What is the birth rate? The relative birth rate now in the SMSA's, as against rural areas? Is the traditional relationship changing? And they also looked at another feature of the density space aspect. You have within the SMSA's the coercity, the urbanized area, and the genuinely rural part. Some SMSA's, of course, do not apply. There are varying growth rates within these sectors. Jenkins insists that the birth rates are higher now in the urbanized areas, offsetting the decline - in other words, they thrive on themselves, and they may maintain this 24% rate. Can you comment on that?

TORGET: Yes. The differential natural increase that has existed in the past has tended to change a little. The natural increase, which is births minus deaths, in the cities has been relatively higher than it has in the past, so their ability to feed on themselves as you are suggesting, has been greater now than it has in the past. Therefore, I suggest the 17.8% should be something more like 19.0%, but certainly not 24%.

FLANNERY: I want to extend this proxy to cover myself. I would like to comment on this resource base projection method. I subscribe to it, but I think we ought to acknowledge there are some criticisms of it, and some severe limitations of it as they apply to smaller and smaller areas. I'm sure you're familiar with this and I'd like your demonstration of what the growth rates have been of Oklahoma cities and Texas communities and their relative numbers that appear in each percentile. However, resources, in the narrow sense, actual resources, means the ground and the trees, and so forth. These are the accelerators that provide the momentum for the economy. But any cluster of communities within a hundred mile radius - you can't say with any kind of rationality as to which one will grow more than the other. I'm groping now for some geographical references. Take Hugo and Idabel in the Oklahoma sector with which Region VII is so familiar. The relative growth of those two - you can't say, "Will an industrial operation come and locate one or the other, or between them, and if they do, will the people live somewhere else and drive?" This is impossible. And what we are confronted with is the necessity of saying "In the area they will live, the population will be cast in some kind of dispersion." The resource base projection method at it's best - of course, is most applicable for a region or subregion. What is a region, what is a subregion? We have to explore them, and all you can strive for is reasonableness, and some acceptability. If you want a particular reference - the articulation or the criticism of the resources base method, it appears now in a book called, "The Critique of Urban Analysis" published by Chandler Press, in 1960. He says some communities do thrive on themselves - Tampa, St. Petersburg - you look at that area of Florida. Miami, Florida, has apparently nothing in the way of resources in the conventional sense. But they are moving rapidly. Those are the two fastest growing SMSA's in the South. Cape Canaveral, Bernard County, Florida, has a zooming growth rate. Huntsville, Alabama, has a similar experience. Some of them are based on a military defense installation that may be short-lived. They say these are the accelerators. The economist calls them the multiplier effect. And we could do much better on a projection or some kind of an approximation of the future in larger areas - in the Chicago metropolitan area, for instance, with a lot more surety. This doesn't say there's any certainty in here. In this respect, I like Oscar Wilde's statement. He says, "I can believe it only because it is incredible." And this is what I think all of these things are, in fact.

SCHEIDT: Jim, what you just said might be elaborated on. You remember you and I discussed a thing called Critical Mass, taking this up to the nuclear sciences. There seems to be some evidence in the things that I've read - that there is a thing called Critical Mass, and that below a certain level, with this current tendency for people to drift to the metropolitan areas and leave the rural areas, the small towns have a tendency actually to disappear. And this, I think, is what you were saying, beyond a certain point - St. Petersburg, for example, thrives on itself. I wanted to ask Gene whether or not in his exploration of size groups, especially the smaller ones, whether you had encountered this, because it seems to be important. Now a small town that happens to be within the influence of a metropolitan area isn't going to disappear. It will presently be merged, but if it is isolated, in spite of resources or anything else - it might even disappear.

TORGET: Yes. We computed the 50-year growth rate of all towns in Texas and Oklahoma and found that many of the small towns - those less than 1,000 population, and those between 1,000-2,500 - were evaporating.

SCHEIDT: Let me just say that I think your whole technique here is a splendid one. I'm glad to hear you say that it is a check - that it isn't the only approach. But I think you'll be happy to know that on your illustration of the Cincinnati figure, where you raised a caution because of past records that your own finding didn't agree with the RFF projection - that they are at this moment revising this figure downward now.

TORGET: How about Ft. Worth?

SCHEIDT: We don't have anything on that. I would urge that this just be one of several techniques.

FLANNERY: Gene, what influence is there in these projections by annexations? Are you able to handle annexations in these communities?

TORGET: No. Actually, on these I threw out those little towns that were in the metropolitan area because as suggested here, they're not growing for their own sake, but because of the larger areas. This does not reflect those towns.

FLANNERY: Aside from that, if you were to throw in Arkansas - a couple of communities - Ft. Smith has had a big growth rate and much of it is atypical to annexation. In other words, Ft. Smith jumps because of area influence.

TORGET: Annexations are not a problem for SMSA's because the whole county is used. It likewise is not a serious problem for smaller towns because normally the city limits are way out in somebody's pasture anyway. I might say that when Bob and I were over at Hugo, I was glad that I had this kind of a historical growth record for this reason: they thought the projections for Idabel, for example, were quite low. Well, we had previously sent out questionnaires, to ask them what they thought their city's population would be by 2010. (Idabel had been bumping along at about 5,000) Their forecast was 150,000. That's what they thought they would attain 50 years from now. As the result of these graphs one can at least show that no town had attained this kind of growth rate, and the best has never attained 1/4 of that rate. This doesn't prove that it can or can't, but it does prove that they're 'way out here in the upper 99.99 percentile - and even that hasn't been attained.

EICHBERGER: Gene, I have no quarrel with your methodology, but I wonder what happens regionally - in an economy going over to the more industrialized economy - what effect will this have on the city of Atlanta? What effect will it have on the large metropolitan center as we go? These have been growing at a certain rate, but as we become more industrial in the future - we will have outlying regions coming in from the rural areas to the cities. But you've also had migration problems from the southeast to the north, and the northeast. Now as we industrialize, what happens to the growth of the metropolitan areas?

TORGET: Up until the last decade, metropolitan areas have been barely maintaining their own population, as far as natural increase is concerned. Migration has been the major cause of growth of the metropolitan areas. Atlanta's rate of growth has been in the upper 1/3 of the metropolitan areas of that size group. The value of the paper is at least this: if Atlanta hasn't had a rate greater than that, you should certainly be cautious to not project one that would be measurably higher than that unless there is some justifiable reason for it. You can see where it grew in relation to other cities. The main virtue of my method is that it gives some boundary lines on the rates of growth of cities.

EICHBERGER: The point I'm trying to make is this: it seems to me there is a little danger here in following a growth pattern - take into consideration the development of resources that heretofore have been more or less undeveloped in a region, so you do have circumstances here where everything you can get dictates that this would attain this level, but actually it could be something greater.

TORGET: Yes, I acknowledge that, and that's why I caution that this should be supplemented by the resource base.

REED: I think my question would be related, Gene. Do I gather from your studies that once a city gets to what we now call the critical point - the critical mass - that it will continue to grow, irrespective of the changing technology? Now what I have in the back of my mind is the fact that of course much of this part of the country being petroleum-oriented, we would draw certain conclusions from past growth, and also if we went to our resource base, we would draw certain conclusions of continued growth. But had we gone back a few years, we would have drawn about the same conclusions about areas in the coal regions. I wonder what the fact this changing technology might have on both your projection and also a resource base, or whether the metropolitan areas do in fact feed on themselves, and these things - that they'll move to some other type of industry and make a shift without any great danger?

TORGET: Well, that's the real heart of the problem. All one has is the evidence or trends of the past, and that's one of the hazards of this or the resource base — and, even though we don't usually say the resource-base projection methodology is based on past trends, it is based solely on past trends in a sense. The fact that we live in houses at all is knowledge of past trends. And so, the change in technique or changing technology is the real hazard in either one of these projections. Yes, you're quite right. However, the coal counties around Pennsylvania and West Virginia have dipped down to the very bottom in growth rates. They haven't begun to feed on themselves very much.

REED: Well, for instance, if you look at your chart on Pittsburg and then look at Houston, you begin to wonder --

TORGET: Yes.

DAVIDSON: I have a number of comments. Of course, the fact that the relative value of the two methods will vary according to the area that's involved, for instance, in an area such as the northwest where the resources are so particularly important, certainly this method would

would play a larger part than merely an extrapolation or projection. That brings up the point of the difference between forecast and a projection. And I've been told if I brought this up, Reverend Flannery would have a sermon, so I will merely pose the question to Reverend Flannery, what is the difference between a forecast and a projection? I have some definite feelings myself, but I'd like to have his reaction, too.

HAYWOOD: This is only a three-day meeting.

FLANNERY: I would refer you to "Conceptual Problems in Projecting Demand for Land and Water" by an agricultural economist. It's reprinted from Modern Land Policy, University of Illinois, and he deals with the definitions as they are - as they try to be verbalizations of concepts. And what I could say here is my dispute is not over which is what - only that when you use them, they will accept some responsibility for consistency. That they aren't substitutes. What I like to do is to keep the reference points clear. If we started from first base, we went past second. We didn't go over the mound to third, which happens frequently. We say we don't want to use the same word twice because it interferes with literary style. There is enough deception - especially self-deception - without using loose wordage. (Editor's note: Yep!)

HAGER: What is first base? This is what keeps bothering us fellows that have the problem of putting these things down in writing.

FLANNERY: The term "projection" has an accepted meaning within statistics, and statistics are some kind of a useful body of knowledge --

HAGER: Projection is the strongest word, then?

FLANNERY: There are words that I use that are stronger than that.

DAVIDSON: For the record, I'm on Jim's side. This is what I had hoped he would say. I wanted to comment further on Jim's point on critical mass and on the importance of the size of the area in using one method or the other. Jim Flannery brought out the point that a resource type study wouldn't be able to decide whether an industry would be in one town or another that would be adjacent. But looking at a slightly larger area, a resource base study would indicate the possibility that a certain type of industry would be located in some subregion. And to carry that further, then, if you look at an even larger region, you get into the area of a critical mass, or a critical size, where one might expect a rather large region to be a proportional share of the nation in its growth. As a last comment, I would like to emphasize the need to look at regions with some logical boundary, rather than binding ourselves, trying to predict for an arbitrary boundary.

Gene brought us up a bit on commenting on the annexation problem - the location of the city boundary. If the city boundary is strictly arbitrary and has no relation to the region, in making a projection or a forecast of the city's population, we'd be on very rough grounds, because one could never predict the annexations.

HAYWOOD: Thank you, John. Let's see, I believe Ken Nobe?

NOBE: Gene, I was wondering - trying to get this technique of yours to some degree of applicability to what we are facing. As you probably know, we have one SMSA. We have a lot of them that would like to be, and we have resources that we haven't even discovered and others that we no longer need, so I'm wondering whether if there's any possible use of your method at all in terms of making check on a resource base study for population in an area such as that where many cases we have only a nucleus for development and nowhere near a critical mass from which to grow - and complicating it even further, the development, population-wise, in this area has not been primarily from rural areas, but from declining other urban areas. Land of sunshine and recreation, for example - they're not going to make a buck, they're out there to spend one - Las Vegas. I'm wondering if you might have some thought as to how adjustment of your method might finally be used to check growth of budding SMSA's which I expect some will develop in the next 50 years.

TORGET: I thought of that - but the difficulty is in the statistics. The Standard Metropolitan Statistical Areas are large enough to include the fringe area outside the central city thus the true growth can be checked between decades. For smaller cities, say in the 25,000 - 50,000 class, the growth rate is not as certain because the growth may have been in the urban fringe and not within the "city-limits". It's the population within city boundaries that you're speaking of in smaller cities and the city boundaries may or may not reflect very positively the changes that have taken place within the urbanized area. So there's this kind of handicap with the smaller cities. However, I do suspect that something approaching this could at least be estimated.

NOBE: Could you particularize this SMSA from another area that has gone over a longer period of time that might - in other words, I mean, similar to some nucleus that could be an SMSA in our area?

TORGET: Yes. I was with the Bureau of Reclamation for a few years, and we had the comparison area. We tried to have the comparison area as near alike in all respects. The only trouble had been that cities, even cities that appear to be similar in all respects - don't match out very closely, unfortunately. One can make comparisons between select cities of various size groups - as you know everyone has been doing this - but then you're always accused of a bias in your selection of cities. In the method I'm proposing, you're taking all cities of the country. There aren't any more. So you can't be accused of being biased when you take the entire universe. Yours was a good point. I just can't answer it, I'm sorry.

DE FALCO: Up in our area we have one metropolitan area - in fact there's no room for creating any new ones. There's some assumption that we're going downhill, but some of our areas we are starting with hat is called the re-birth and which will come after this, after so many of these other areas. Our big resource up in our area is labor, and in the coal mines - this was raised before - where the resource is not depleted but the market has, we are now converted toward electronics and textiles, and this is creating a change in trend. We've already passed the zero point in some of these areas up in New England, the textile, the electronics have come in. These are mainly using the large labor force available. Now this changes some of our projections as far as our upper limit is concerned, and I don't know how we can handle it under this method.

TORGET: That is true. The metropolitan areas that were in the bottom 10 per cent bracket, or in the bottom 20, at least, were primarily in your region. Some seem to think my approach is purely statistical or mechanical, I don't think it's quite as mechanical as some would say, for this reason: the growth rate of any city is a combination of a bunch of all the factors that cause growth. Perhaps it had a mediocre labor supply but a very good tax structure, transportation was essentially good but the climate was lousy and so. The method shows the effect of the growth factors but doesn't identify them. It says, "Well, the combination gave this kind of a pattern." And now then you're suggesting that the combination will give some other pattern. That might be.

DAVIS: Gene, I've been hoping that some of these outstanding scientists and engineers from Cincinnati would ask this question. Cincinnati is one of the low men on the percentile totem pole, and I'd like to have that SMSA for Cincinnati defined. The reason I ask this is that I am aware, and you, as a future resident adding to the population of Cincinnati are going to find, that Cincinnati in Hamilton County is a saturated community. It is adjoined by Montgomery County, Anderson County, and two saturated communities across the Ohio River, over in Kentucky, especially saturated Newport, and if you were to fly over this area, you would see it expanding almost as Dallas is around this whole fringe. So I wonder if this SMSA really does include this tremendous growth that we've got on the fringe outside of what is normally considered Cincinnati?

TORGET: Cincinnati includes, as I recall, about 6 or 7 counties. There are about 4 in Kentucky, and 3 in Ohio, so, now these areas were just revised in 1958 or 1959, isn't that right, Jim?

FLANNERY: There's a recent publication by the Bureau of the Budget, a 60-page mimeographed document, what our current SMSA's are.

TORGET: The definition of Standard Metropolitan Statistical Area is that which is contiguous and inter-related, so therefore I'm sure that they did pull in all the counties influenced by Cincinnati. In other words, in Dallas, for example, they have not only Dallas County, but three other counties each having a population of around 30 or 40 thousand. I feel the explanation of why Cincinnati has a low relative growth rate is not explained by your comment.

KEHR: As a matter of information I'd like to ask, the development of Table 9, decade 1930 to 1940 was excluded. In other words, this is a period - this period was one of severe economic conditions, and did have a very low growth rate for most areas. Was that decade excluded as atypical in the development of Table 9?

TORGET: It was excluded, yes.

KEHR: I'm wondering why, in view of the fact - if you were going back into preceding centuries, the depression that occurred during the latter part of the 1800's might have indicated that some consideration should have been given to the possibility of a recurrence of these severe economic conditions. It would not make a great difference, but it might be of a little greater accuracy.

TORGET: From 1960 to 2010, these 50 years, we're assuming a growth curve of the total Standard Metropolitan Area, it is slightly curvilinear. This is the average. Deviations from this average will occur but I can see no way of predicting these cycles. What we really want is the water demand 50 years hence and intervening fluctuations from the long-run curve is not too important.

HAJINIAN: First of all, we know that this is only Oklahoma and Texas. Each area will have to do their own analysis, and I'd like to answer Bill Eichberger's question. This is what I want to bring out. You said now, I don't know how many years the South has been becoming industrialized. Well, that would come out in this method, because you'll have industrialization increase from 50 to 60, which would show on this method.

EICHBERGER: I want to defend myself here. What I said was, you may have a situation if industrial development and resource development that heretofore has not occurred, that may change this thing, and it would not be reflected in this. This is my point.

HAJINIAN: We have a theory here that this may look like a purely statistical historical trait, but it is not. We feel that resources have been taken into consideration in the past. Now you tell me, how do we project resources we know nothing about, or don't even know that they exist? We knew nothing of uranium 20 or 30 years ago, so how would anyone project a place like Albuquerque? That's why we feel that this is the best method we could come up with.

TORGET: It at least puts bounds on it.

HAJINIAN: That's all we say. We don't say you should mark this exactly on the line and do an analysis and move it where the line is, but make sure you're in the same ball park. That's all it is.

DWORSKY: Just to add some other facts into the record, I do think it's important to recognize that there are certain social and governmental factors that also play a very important role in what happens in populations. Currently, there are quite a number of them - the current situation in the Defense Department - when you see military establishments - they're a very important factor. The problems with respect to Puerto Rico and its impact on certain areas in the country. It's more constricted, of course, but still it's a fact. And finally, there's the longer term problem - the one that the President is now working on - in terms of depressed areas, re-training and mobilization. The mobility of those people to areas for work. And lastly, but not of least importance, is that one that has a very significant effect - the one about integration. This, of course, has a very serious effect because of the movement of the population as of the last decade is again forcing us to change. There are other, racial, religious factors that are playing a very large role in changing the basic structure of our cities. These do make it difficult to forecast population in the future.

HAYWOOD: I don't think what Gene has proposed is intended to be like a tax table that you can leaf through and on page 201 find the answer to your question. I think it has a great deal of merit. I think it must be used with judgment, like everything else. As it is used it is going to find its place, and I, for one, think it's a very valuable addition. I'd like to comment on two points. One, Gene mentioned the fact that we have looked at small towns. The political implication of these studies needs no discussion, but the fact of the matter is that in our studies we find that significant water demands haven't occurred and are not apt to occur in small towns. The total demand of some of the rural areas is a rather small percentage of the total water demand in our states. Nonetheless, we feel it is very inadvisable to skip any town. We had that lesson brought home to us very early in the game. We visited two towns in northeast Texas - in one town we were well received, a meeting was arranged whereby our people had a chance to talk to a number of townspeople - they took the initiative themselves in doing this. Our engineers and staff people went back and made the presentation. We gave the same opportunity to the other town. They made no effort, they didn't help, they didn't arrange a meeting. The first thing we knew we got a complaint from Washington that we had not given that town an opportunity to present their side of the picture. This can be repeated time and again. This is one of the reasons for visiting small towns and furthermore it does contribute to the total demand of the study area.

OWNBEY: I think that Gene has been unduly modest in presenting this method. It has been suggested that this is a supplement to resource approach as a sort of check-rein on the answer obtained by the resource approach. It seems to me that we still leave the question; if you come up with two different answers, or two approaches, we have to come to rest on one. So, which of these two is given the greater weight? I think that depends on the locality. As John Davidson was saying, in an area such as the Northwest, the chances are that the resource base would be given the greatest reliance. But in other places, the mature cities - those with critical mass - greater reliance might be placed, if you have to make a choice, on Gene's approach than on the resources, if there is a final conflict between them. I think what I'm saying is that these should be twin methods and not one subordinate to the other in all cases.

TORGET: Thank you, Ray. Which is superior? I will say that the degree of confidence that we can place on any one is not as high as any one of us would like. If you take a look at Dallas, much of the growth that one can project on the basis of the resources is quite small. Now I'm including all resources - sunshine or anything else. One is rather handicapped by finding a real substantiation for a projection. So quite frankly, I have used this method for the projection of Dallas. I know of no other way of saying exactly what the competitive advantage of the labor supply in Dallas is. There are no resources aside from space and sunshine and things of this nature. So therefore, this kind of statistical approach seems to me the one that I had to rest on, and then sort of work backwards and inject, given this kind of growth, what would have to fill in the vacuum to get that kind of growth. If there are greater insights, I, for one, would be very receptive to receiving it. The larger the city is, as Ray suggests, the more there is of this category that is hard to project. Albuquerque, for example, an area of sagebrush and jackrabbit and blowing sand. What do they have in terms of resources? It's quite difficult to make a projection on that basis. So therefore, this method, I feel, is one that I seem to have greater reliance on. That's about the point. But, of course, again, with John Davidson, where you have a proportionately large section oriented to resources, one can have certainly greater confidence in that kind of a method. I agree one hundred per cent on that.

HAYWOOD: We've run into a resource in some of our studies down here that you can't measure in any way, shape, or form. The resource of the enthusiasm of local groups for bringing industries in. If any of you can come up with a yardstick there, Region VII would like very much to have it.

GROWTH FACTORS IN ECONOMIC BASE STUDIES[1]

This paper is concerned with the application of growth factors to economic base studies and the consideration of whether the values for these factors can be standardized.

The term "growth factors" has been selected to refer to a class of terms which are used to describe some of the important changes in the relationships between parameters of the economy. Examples include the so-called productivity factor which describes the changing relationship between the output of an industry and the quantity of labor employed. To illustrate, if the productivity of the workers in a certain establishment increases over time and the output of the plant is to remain the same, then fewer workers will be required in the future or the same number of workers will work shorter hours.

Another example of a growth factor is the changing relationship between employment in primary (sometimes called basic or externally-oriented) industries and the number of service (sometimes called secondary or internally-oriented) industry employees that are required to serve them. When employment is converted to population, a third example of a growth factor is found in the changing relationship describing the number of persons in the population per worker.

As a first step in examining the nature of growth factors it is desirable to examine how they will be used. They will, of course, be a part of the economic study - more properly called the economic base analysis and forecast. Although such studies are made for a number of purposes, our interest in the economic study is usually as a tool to provide basic data and forecasts about water consumers, users of water resources, and contributors of pollution. By keeping such goals in mind, the economic study can avoid getting into irrelevant areas or providing unnecessary detail. I think that we can agree that some of the more important statistics which should come out of the economic study would be population, employment, industrial output (for many, but not all, industries) and land use.

In order to get a better look at the economic study and to recognize the role of growth factors it is helpful to construct a model. The construction of such a model is also one of the basic steps in preparing the economic study. It should be pointed out that many of the people who prepare economic base studies use the model technique without calling it such. The concept of a model, however, is particularly important because it assists in the recognition and

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[1] Prepared by John H. Davidson, U. S. Public Health Service, Portland, Oregon, March 1961.

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definition of the important relationships between segments of the economy. The acknowledgment and understanding of the causes and effects of various economic features is basic to interpreting and forecasting the economy of a specific area. Such an understanding can frequently point the way to avoiding two dangerous over-simplifications frequently encountered in forecasting. These are (1) blind extrapolation of historical trends, and (2) assuming that the study area has exactly the same characteristics as the Nation and will maintain its same relative position. It should be recognized that the use of a model does not necessarily mean that an equation must be written. Many worthwhile economic studies are conducted on a much less formal basis, with the model being described in sentences rather than by a formula.

As a basis for the model we need to know some of the fundamental relationships between the facets of the economy which relate to the statistics we want to obtain. One important such relationship is indicated in the concept that some economic activities which involve employment of persons are of a primary nature and others are of a supporting nature. Although the distinctions are sometimes difficult to make, a very useful tool is derived by classifying all industries[1/] into either externally-oriented industry or internally-oriented industry and examining the numerical relationships between their respective employments.

It should be noted at this point that the reference to either external or internal orientation of industry has been selected to attempt to overcome some of the shortcomings of other such pairs of terms for industry as basic and non-basic, primary and secondary (or service), etc. These classifications can be briefly defined as follows:

> Externally-oriented industries depend on the particular resources or manufacturing opportunities of the area. These opportunities allow, in theory, for the production of goods in excess of the requirements of the community. The excess is exported from the area, and products from other areas are imported. The internally-oriented industries, in general, depend on the consumer needs of a community. They supply goods and services sufficient for the community and grow when the community's externally-oriented industries develop.

When using this model approach, it should be recognized that the bigger the study area the less valid is the technique. As a ridiculous example, if the whole United States is considered, there is very little basis for making a distinction between primary industry and supporting

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[1/] The term "industries" is used in the broad sense to indicate all types of value-producing activities. These activities include those relating to both goods and services and not just to manufacturing.

industry because about 95 per cent of our national economic activity is for internal consumption. On a community or local area basis, however, it is typical to find about half the economic activity is internally-oriented and half is externally-oriented. The ratio between these two types of industry is usually a function of the size and diversity of the community's or area's economy. Depending upon the area, the ratio can vary from, say, 1/2 worker in internally-oriented industries per worker in externally-oriented industries in a rural area to a ratio of 2 or more in an urban area. The important point here is that from a forecast of externally-oriented industry one has a basis for deriving the extent of internally-oriented industry. In like fashion one can convert employment to population by multiplying the employment by the number of persons in the population per worker. This ratio will vary considerably for different areas but averages about 3 persons per worker. Although changes in this ratio over a period of time would be expected for various areas, it is interesting to note that the Department of Labor estimates[1] of total labor force participation rates for 1975 are almost unchanged from the 1955 level.

A simplified expression of this model would be as follows:

(Externally-oriented industry workers) (K_1) = (Internally-oriented industry workers)

(Externally-oriented industry workers) + (Internally-oriented industry workers) = (Total workers)

(Total workers) x (K_2) = (Population)

where: K_1 is the ratio (for the study area and study period) between workers in internally-oriented industry to those in externally-oriented industry, and K_2 is the ratio of persons in the population per worker.

From this model, by assuming some average values for K_1 and K_2, one can develop a useful rule-of-thumb for estimating the effect on population of a new industry in a community. Assuming that $K_1 = 1$ and $K_2 = 3$, then one new worker in an externally-oriented industry would, on the average, add one new worker in an internally-oriented industry, and would bring about a total population increase of six persons, considering the families of each of the workers.

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[1] Population and Labor Force Projections for the United States, 1960 to 1975, Bulletin No. 1242, U. S. Department of Labor, Bureau of Labor Statistics, June 1959.

In the construction of a model as the basis for a forecast of the future economy, one of the major efforts would be the development of a forecast of the total workers in externally-oriented industry. This can be done by forecasting each of the major components of such industry. The forecast of these components usually includes the consideration of productivity of labor. As mentioned earlier, other factors such as the length of the work week might also affect the number of workers.

The measurement of productivity, for our purposes, is mainly a problem in estimating its relative change over time. The attached chart has been prepared to illustrate the annual rate of change for selected industries. The annual rates of change were based on two indicators of output. In the first part of the chart physical units of output were used. In the second part of the chart the output product was measured in constant dollars. The wide range of annual change among the selected industries should be noted.

The rate of annual change also varies considerably over time. A hasty measure of this can be derived from examination of the U. S. Bureau of Labor Statistics Index of total real private product per manhour. For the period 1950-1959 its average annual increase amounted to 2.8 per cent, for the period 1947-1950 the annual increase was 4.5 per cent, and for 1941-1947 it was 1.0 per cent. Over the last 50 years the annual change of this index has averaged 2.2 per cent.

From this discussion and from the chart it should be obvious that the productivity factor varies considerably depending upon the industry and the time for which it is measured, and that this might have a considerable effect on the economic model. However, rather than digress any further at this time on the subject of constructing models of the economy, I have included as Appendix I some further notes about the construction of a model such as we are using in our studies of the Pacific Northwest.

With this background the question which prompted this paper can now be examined. This question was initially stated as follows:

"Productivity increase factors - can they be standardized?" We have broadened this question by considering other related growth factors as well. Examination of the nature of the coefficients in the simple equation developed as a model of the economic base provides a logical answer to our question about standardization. Because these coefficients are developed from the study of areas with specific conditions, they can generally only be applied to areas with similar conditions. Obviously, it would be wrong to use national factors for a local situation unless the local situation was completely typical of the Nation by having the same conditions of influence as the Nation. It is probably safe to say that national growth factors should only be used as guides in making economic studies of local areas. Growth factors, therefore, can only be standardized when the individual study areas are identical with standard conditions. Because this is not often likely, we must modify or develop growth factors to meet the situation found in the study area.

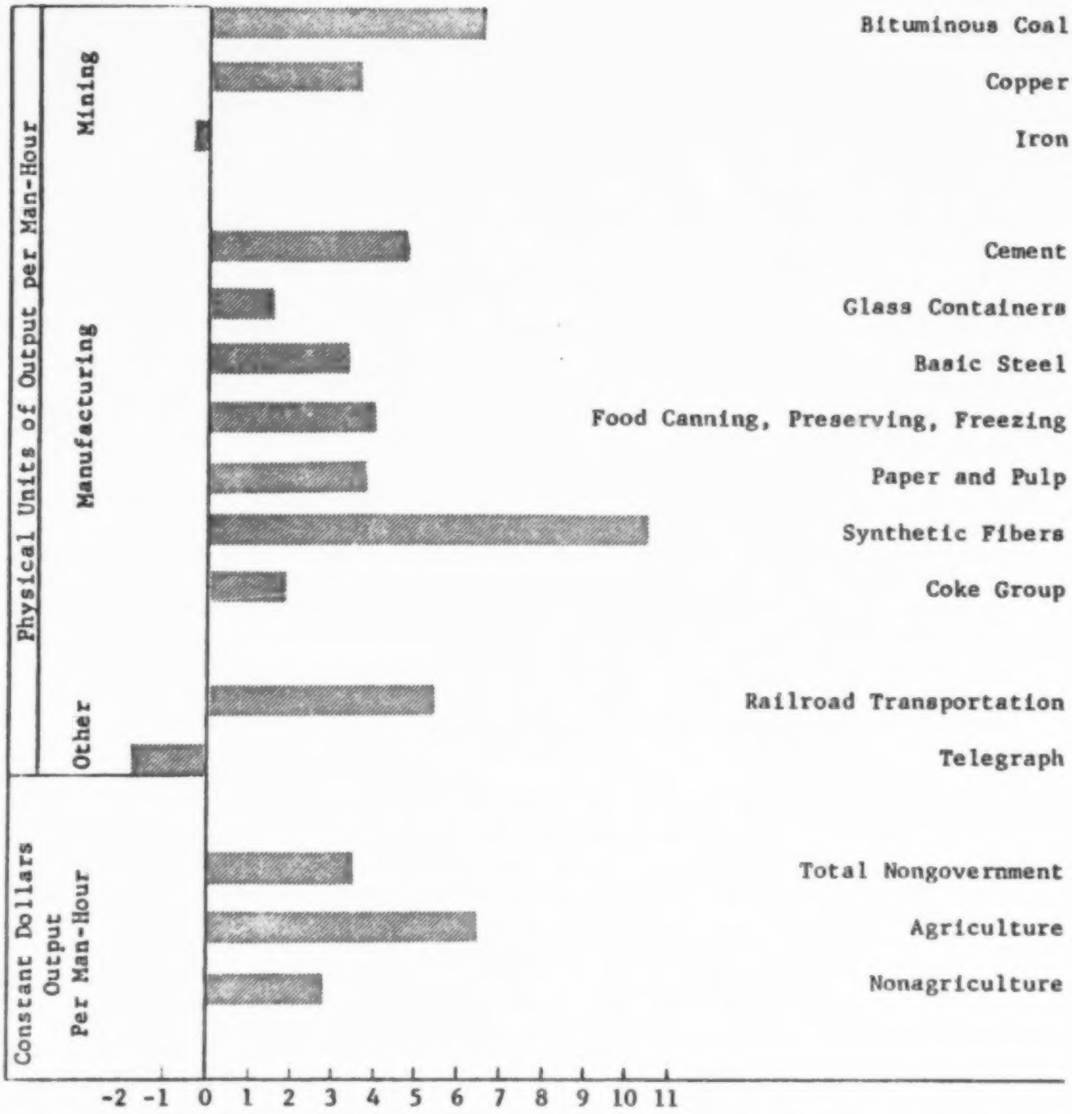
Even though this point of view precludes the preparation of a single set of factors to be plugged into all economic studies, I feel that the approach or methodology involved in making economic studies is more subject to standardization. Although it is not possible or desirable to lay out a cook-book approach that will serve all needs, it should be feasible for us to agree on the general principles and standards for such studies and then to work cooperatively toward the improvement of techniques and the sharing of basic information. Since I have taken the position that standardization of growth factors is not generally feasible, there is little opportunity for me to complete the use of my allotted time with the presentation of a tabulation of standard factors. In lieu of this, I am attaching as Appendix II a brief annotated bibliography of some interesting publications in this field which might provide some additional background on procedures and sources of information.

In addition, I wish to make a few brief comments about some of the influences to be considered in developing these various growth factors. One of the influences on the possible number of employees is the length of the work week. One simple rationalization that could eliminate further adjustments is to assume that the decrease of the work week will exactly offset the increased productivity due to such factors as automation. It should be considered, however, that any possible shortening of the work week will likely be greatest in manufacturing industries and will probably not occur at all in many industries, particularly small service industries.

The matter of productivity is of interest not only in regard to employees, but also with respect to the output of the land resource. We have witnessed in the last few decades some tremendous changes in the productivity of farm land. We have also seen a considerable mechanization of farming processes. In many areas, however, this latter has not decreased the number of persons employed on farms because there have been other changes, such as irrigation, which have resulted in more intensive use of land and an increase in the labor requirement of this land.

Increased productivity from forest land will probably be one of the dramatic changes to occur in the future economic base of the Pacific Northwest. Experiments now underway indicate that fertilization of forest areas and the application of genetic principles to tree harvesting and reforestation will have a tremendous effect on the productivity of this resource.

Productivity Factors for Selected Industries in the Private Economy
Annual Rate of Change for Last Decade



Percent of Change, Compound Annual Rate

Source: Computed from statistics in: Economic Forces in the U. S. A., U. S. Department of Labor, Bureau of Labor Statistics, May 1960, pages 118-120.

In conclusion, I would like to summarize some of the main areas to be examined in this paper. These are enumerated as follows:

1. Economic base studies are facilitated by the use of models which define the important relationships between segments of the economy.

2. The model generally contains the growth factors expressed as coefficients modifying the various basic statistics.

3. The growth factors can only be standardized when the individual study areas meet standard conditions; therefore, standardization of growth factors usually is not feasible.

4. Standardization of methodology is a feasible and worthwhile goal.

APPENDIX I

Notes on an Economic Model of Future Employment and Population in the Willamette River Basin of Oregon.

A. Introductory Notes

1. The model described in this appendix is not intended to be a complete description of the economy, but merely presents a procedure for analyzing employment. This procedure is particularly important, however, because employment can be, and frequently is, the common denominator for various parameters of the economy. Employment can also be utilized as the basis for both water use and pollution contribution studies.

2. The application of the model to a basin requires some judgment as to the size of the sub-area to be included. For convenience, the area to be covered in one model study should be relatively homogenous. It is planned in the Willamette Basin to make three model studies to cover the upper, middle, and lower sections of the Basin. Each of these sections has distinguishing economic characteristics.

3. Comparisons of the model's results with forecasts prepared by other means and with forecasts of the region or Nation are an important part of the forecasting process. Such comparisons not only provide a check on results, but where a significant difference in results occurs, valuable insight into the economy is gained by accounting for the difference.

B. Components of Model

1. Externally-Oriented Industry Employment Forecast (E_{xf})

Expansion in each significant component of this category will be forecast and the resulting employment computed, taking into account possible changes in productivity of workers or changes in the work week. The forecasts of resource-based industries will recognize the limits imposed by the extent of the resource. Similarly, the forecasts of market-oriented industries will recognize the limits imposed by the marketing areas. Forecasts of other nonresource-oriented industries will recognize the limits imposed by marketing areas. Forecasts of other nonresource-oriented industries will be mainly based on national trends. The major industrial categories to be considered are:

Mining
Agriculture
Fisheries
Forest Activities
Manufacturing (by major classification)

Also to be considered in this category are those activities generally thought of as internally-oriented, but which actually are based to a significant degree on external influences. Examples would be tourist facilities or transportation facilities which would serve a much larger area than the local industry or market would justify.

2. Internally-Oriented Industry Employment Forecast (E_{if})

Employment in these industries will be computed by multiplying the externally-oriented industry employment (E_{xf}) by K_1, the ratio of internally-oriented industry workers per externally-oriented industry worker. This ratio would be adjusted to reflect the nature of the study area and the growth of this ratio over time.

3. Total Employment Forecast (E_{tf})

The forecast of total employment is the sum of the forecasts of each category of employment. This can be expressed as:

$$E_{tf} = E_{xf} + E_{if} \quad \text{or} \quad E_{tf} = E_{xf}\,(1 + K_1)$$

4. Population Forecast

The population is computed by multiplying total employment by K_2, the ratio of the number of persons in the population per employee. This ratio would be adjusted to reflect such trends as a growing number of households with more than one person employed. The number of households and dwelling units would be forecast from the population, recognizing the trends in family size, etc.

The model for the population forecast would be expressed as follows:

$$P = (K_2)\,(E_{tf}) \quad \text{or} \quad P = K_2\,(E_{xf})\,(1 + K_1)$$

APPENDIX II

Bibliography of Selected References on Economic Base Studies and Data Sources.

MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS OF THE KANSAS RIVER BASIN.
Charles E. Staley. Center for Research in Business, The University of Kansas, Lawrence, Kansas. October 1960.

Has a discussion of models and an example of their use in the systematic exploration of future industrial use of water. Also has employee productivity data (including forecasts) and discussion of this subject.

PROJECTIONS OF THE LABOR FORCE IN THE UNITED STATES 1955 to 1975.
Gertrude Bancroft, Bureau of the Census, Washington, D. C. October 1956.

Has projections, by age and sex, of labor force and participation rates. Utilizes four sets of assumptions in projections.

EMPLOYMENT AND WAGES OF WORKERS COVERED BY STATE UNEMPLOYMENT INSURANCE LAWS AND UNEMPLOYMENT COMPENSATION FOR FEDERAL EMPLOYEES BY INDUSTRY AND STATE.
U. S. Department of Labor, Bureau of Employment Security, Washington, D. C. Third Quarter 1959.

A handy source of recent statistics on "covered employment."

WESTERN EMPLOYMENT TRENDS, 1947-58.
Western Regional Report #6, U. S. Department of Labor, Bureau of Labor Statistics, San Francisco, California. August 1959.

Analysis of total employment trends by major employment divisions, for eleven western states. Region is compared with the United States.

EMPLOYMENT DEVELOPMENTS IN THE PACIFIC NORTHWEST AND ALASKA.
Bureau of Employment Security, U. S. Department of Labor, Seattle, Washington. January 1960.

An example of the periodic reports on employment prepared by the Bureau of Employment Security. Has monthly employment data, by major employment divisions, for Pacific Northwest States and Alaska.

1961 PRUDENTIAL'S ECONOMIC FORECAST.
The Prudential Insurance Company of America, Planning and Development Department (Tenth Edition). December 12, 1960.

Brief statement of the industrial and commercial economy, on a national basis, with a forecast for 1961.

PRODUCTION TRENDS IN THE UNITED STATES THROUGH 1975.
Bonnar Brown and M. Janet Hansen. Stanford Research Institute, Menlo Park, California. March 1957.

Contains projections of the national economy through 1975, broken into 13 broad sectors. Projections include employment, gross product (based on Gross National Product), and gross product per employee.

THE AMERICAN ECONOMY; PROSPECTUS FOR GROWTH TO 1965 AND 1975.
McGraw-Hill Publishing Company, Inc., Department of Economics, 1958.

Contains projections of the national economy through 1975. Projections include population, productivity, work week, investment, raw materials, power, consumer expenditures.

EMPLOYMENT, GROWTH, AND PRICE LEVELS. PART 1 - THE AMERICAN ECONOMY: PROBLEMS AND PROSPECTS.
Hearings before the Joint Economic Committee, 86th Congress, Sec. 5(a) of P. L. 304 (79th Congress). March 1959.

Analysis of national economy - mainly during last decade. Has projections for 1964.

POSTWAR MOVEMENT OF PRICES AND WAGES IN MANUFACTURING INDUSTRIES.
Harold M. Levinson and supplementary technical material to the staff report of George W. Bleile and Thomas A. Wilson. Prepared in connection with the Study of Employment, Growth, and Price Levels, Joint Economic Committee, 86th Congress. January 30, 1960.

Analysis of manufacturing industries with respect to prices and wages. On a national basis and mainly for 1947-1958 period.

PRICES, COSTS AND OUTPUT FOR THE POSTWAR DECADE: 1947-1957.
Charles L. Schultze, Committee for Economic Development. Library of Congress Catalog Card Number: 60-8582.

An analysis (on a national basis by broad sectors of the economy) of prices, costs, and output for 1947-1957.

REGIONAL TRENDS IN THE UNITED STATES ECONOMY.
U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, Office of Business Economics, Washington, D. C. 1951.

Analysis of economic, population, and employment trends by region and state for several decades ending in 1950.

ECONOMIC GROWTH IN THE UNITED STATES, ITS PAST AND FUTURE.
Research and Policy Committee, Committee for Economic Development. February 1958.

A general statement on national policy. Does not have detailed statistics.

MANPOWER CHALLENGE OF THE 1960's.
U. S. Department of Labor, Washington, D. C. 1960.

A general statement on a national basis, of the manpower requirements to 1970.

SOME PROJECTIONS OF POPULATION-HOUSEHOLDS-LABOR FORCE 1970. Part I.
Research Department, The Curtis Publishing Company, Philadelphia, Pa. Release #241. August 1959.

A brief compilation of recent forecasts, on a national basis.

ECONOMIC REPORT OF THE PRESIDENT.
Transmitted to the Congress, January 20, 1960. U. S. Government Printing Office, Washington: 1960.

Source of historical economic data on a national basis.

INDEXES OF OUTPUT PER MAN-HOUR FOR SELECTED INDUSTRIES, 1919 to 1958.
U. S. Department of Labor, Bureau of Labor Statistics, Washington, D. C. April 1959.

A convenient collection of indexes (on a national basis) published by The Bureau of Labor Statistics.

EMPLOYMENT AND EARNINGS.
U. S. Department of Labor, Bureau of Labor Statistics. Vol. 6, No. 11. May 1960. (Annual Supplement Issue).

Detailed employment data by industry, state, and metropolitan area.

1960 SUPPLEMENT TO ECONOMIC INDICATORS, HISTORICAL AND DESCRIPTIVE BACKGROUND.
Prepared for the Joint Economic Committee by the Committee Staff and the Office of Statistical Standards, Bureau of the Budget. 86th Congress, 2nd Session, U. S. Government Printing Office, Washington.

Statistical data on a national basis.

DIVERSIFICATION OF MANUFACTURING EMPLOYMENT FOR STATES AND METROPOLITAN AREAS.
U. S. Department of Commerce, Business and Defense Services Administration, Office of Area Development, Area Trend Series No. 5, June 1960.

Report presents an index of manufacturing diversification useful as a research tool in economic base analysis.

AREA DEVELOPMENT BULLETIN.
U. S. Department of Commerce, Office of Area Development.

A monthly bulletin describing studies and references on area development activities.

MARKETING INFORMATION GUIDE.
U. S. Department of Commerce, Business and Defense Services Administration.

A monthly bibliography of publications relating to markets, economics, etc. Includes public, private, and foreign sources.

ECONOMIC FORCES IN THE U.S.A. IN FACTS AND FIGURES.
U. S. Department of Labor, Bureau of Labor Statistics, May 1960.

Contains selected economic data, mainly on a national basis. Includes a chapter on economic output, which contains data on productivity.

PRODUCTIVITY.
Relations News Letter by General Electric Company, August 1960.

A brief discussion of productivity with data illustrating 50 years of the national trend.

NATURAL RESOURCE ENDOWMENT AND REGIONAL ECONOMIC GROWTH.
Harry S. Perloff and Lowdon Wingo, Jr., Resources for the Future, Inc., Reprint No. 24, December 1960.

An examination of the historical growth of various regions from the standpoint of the influence of resources.

DISCUSSION

James J. Flannery
Economist, Water Resources Planning Section, Technical Services Branch, Division of Water Supply and Pollution Control, Department of Health, Education, and Welfare, Washington, D. C.

As a first step in the examination of the productivity concept, John Davidson makes an excellent case for the systematic appraisal of an economy through the use of models. He notes correctly that many appraisers use models either without being aware of it or without formalizing them. A model, of course, is the arrangement of factors to be analyzed for their implications for the future. Since a formal model is expressed as a mathematical equation (and you will note that John's model is in such form) there is a strong suggestion of precision involved. The suggestion is not warranted, however, especially in regard to long run analyses. The most that can be claimed is some approximation of the dimensions of the future. Lest one suppose that this modest claim discloses the inadequacy of economics as a "science" or body of systematic knowledge, let the skeptics and scoffers reflect on the "precision" of predictions of stream quality conditions when complex industrial wastes are involved. Most engineers and scientists acknowledge that laboratory conditions are not likely to be reproduced in the stream.

Acknowledging the relative imprecision of "sizing" the future economy does not destroy the validity of model building as a feature of the analysis. Probably the chief merit of the model is associated with its construction. The identification of the factors to be appraised and the establishment of their relative weights induces a systematic and rigorous procedure in contrast to more casual operations of an intuitive and impressionistic nature. The identification of the factors and the attempts at establishing their importance in quantative terms often reveals that the correct or most thorough questions have not been raised or that the correct or adequate data have not been assembled. In other words, the systematic and rigorous procedure required to develop an explicit model contributes to the credability of the result. This judgment is true also of a model that is not finally stated in mathematical terms, though it is less likely that such a verbal model will achieve the best analysis. Those who are temperamentally disinclined toward formal models can benefit immeasureably by constructing verbal models which state explicitly the assumptions that are accepted as valid and how the assumptions relate to each other.

As John has stated, this frame of reference and procedure is the starting point for the appraisal of economic problems. The productivity problem, that is, the expected changes in efficiency over time - whether in the use of man power or resources by improved technology or other factors - can be handled by development of a model. The validity of the model will be dependent, of course, on the amount of knowledge of the particular aspect of productivity involved. On this point, economics is dependent on other specialties for the basic parameters. For instance, chemical engineering must provide the data on various chemical plant processes to permit appraisal of future conditions. A concrete example of this productivity appraisal is the study by Vernon Ruttan, economist of the Resources for the Future, on the probable changes in efficiency of water use by steam electric power plants. This study indicates a considerable reduction in gallons per kilowat hour. Ruttan applied his model on the data obtained from the Ark-White-Red Study of 1950. The implications of his study for water development projects are tremendous.

Of course, one does not need the Ruttan study to be aware of the importance of productivity changes directly in the field of water operations. For instance, most PHS reports indicate an expected productivity change in municipal waste treatment up to 90 to 95 per cent of B. O. D. removal. The current degree of removal is probably from five to ten percentage points less than that. Expected improvements in waste treatment in the industrial waste field pose more difficult questions. As a concomitant of the waste treatment productivity change, there is a question of productivity change in industrial process water and cooling water. At the present time there are few firm dimensions on industrial water use. The importance to waterplanners of some analysis of future expectations is obvious.

GENERAL DISCUSSION

HAGER: One question, John, where do the unemployed fit into your internally or externally oriented - and how do you consider them in the labor force? They are here in an area - in some areas there are more or less than others. Have you anything to say on this?

DAVIDSON: The effect of unemployment would be like the effect of retired people and other nonproductive categories. That would be mainly shown up in the ratio of the service industries to the - internally oriented industries to the externally oriented industries. On the average, as long as the conditions weren't completely abnormal, one could very neatly handle it this way. It would reflect a higher ratio.

TORGET: This is in reference to the productivity John has mentioned. (Mr. Torget came to the speaker's stand and put a formula on the board - 3/10 + 1.164 x .75 = 1/2.) I'm showing the variation in the productivity formula. Stockton and Cella assumed an increase in productivity of only 25 per cent for the next 50 years. We have been assuming a productivity increase of 164 per cent and then reducing it by one-third on the assumption that the work week will be 30 hours rather than the present 40 hours. Stockton and Cella are assuming a productivity increase of only 25 per cent. That is a significant variation. What is a reasonable figure?

DAVIDSON: I didn't put the formula in the text, because there is a tremendous variation. Now are there any other comments on the variation - a reasonable number to use?

NOBE: I want to point out another question regarding the use of a model. Technology becomes a factor which no one can comprehend. The minute we begin to use a model, we are stuck with a single series of assumptions and it's all tied to this model. What I would prefer to see is the use of a series of models which would probably reflect the range of possibilities which could occur. To use a model assuming the minimum productivity rate, another an outlandish one, and then try to determine a probability analysis as to what in this range, certain things are likely to occur. And I find in an area, especially in an undeveloped area, where there are many different realms in which it can go, if you stick to one model, you lose the validity.

DAVIDSON: I certainly agree. That's a worthwhile way to approach it.

NOBE: I would propose the use of another tool. If a model can be constructed, then by linear programming and IBM techniques a number of models could be worked simultaneously much quicker than a man can sit down with a pencil and work out one.

DAVIDSON: Yes. I think this last suggestion is an interesting one for speculation. I think there is certainly enough technique that will be very interesting to explore to see how we might play with the model once we get it set up, to recognize the wide variety of changes. I think we're working toward this - I think we're some way from it yet.

SCHEIDT: I understand the purpose of these techniques, although I'm a little bit muddled sometimes when I depart from the field of engineering - where we are trying to arrive at some sort of basis for estimating population in order to find out how much water the population itself might use - where our objective is to try to estimate the amount of water. I'm wondering whether a more suitable technique might not be to relate water use to product itself, rather than to the employees on the productivity basis. In a study that I was participating in several years ago, we arrived at conclusions with respect to the petroleum industry. We were at a complete loss because automation was coming into the picture so rapidly that any relationship between water use and the petroleum refining industry and employment was totally useless. Whereas, a relationship between water use and the product of a refinery in terms of water per thousand gallons of gasoline, or what have you, is a much more useful tool. Do you have any comments on that with respect to industries in general?

DAVIDSON: I can't seem to disagree with anyone. I certainly believe in the text - I have the feeling in our study plans to approach for certain specific industries the analysis of the particular industry on a dual basis - one is employment, because employment is such a useful common denominator for many things, particularly as an estimate of the future population. But at the same time, one must examine the output. Hopefully we can relate output to employment, but not always. As Mel points out, as the industry is just starting, or in a regional analysis as it first enters an area, we have very little to base our relationship upon, so we must examine the independent variables for specific industries. We must examine the output at the same time and probably separately from the employment.

HAYWOOD: I'd like to comment on this industrial water use. I have a little background having worked in industry about 15 years. First, a word of caution - when you get industrial water use, look at it very critically. I say that for this reason: I have argued with plant managers to get them to put in one meter - one water meter - without success. Just to get a figure of water that goes through a plant without knowing more about it is going to leave you just as much in the dark as you are now. As far as a change in industrial water use picture is concerned, all of us are aware of the fact that the biggest single industrial use is for cooling. That's not always going to be so. Industry has many approaches to cooling. It can go to air cooling. It can go to cooling towers. There are many other ways of getting the same results. Cooling with once-through cooling water is just one approach. Industry can, and industry will reduce the amount of water that is presently being used. And the thing that's going to dictate when and how much, is the dollar value. I have checked back with two industrial plants on the Sabine River and the Gulf Coast, talking with the Assistant Plant Manager in one instance and the Plant Engineer with a group of his associates in another. The Assistant Plant Manager said simply this, "When the cost of water gets so high, we'll simply move this process to some other area where water is cheaper." But he can continue to do that just so far, and then he's going to come to the end of such areas.

SCHREEDER: At this particular time we are going to ask for conclusions.

DAVIDSON: I'll read them one at a time and we'll discuss them. The first one is: Economic Base Studies are facilitated by use of models which define the important relationships between segments of the economy.

The second one is: The model generally contains the gross factors expressed as coefficients modifying the various basic statistics.

Third, the growth factors can only be standardized when individual study areas meet standard conditions. Therefore, standardization of growth factors usually is not feasible.

Fourth, standardization of methodology is a feasible and worthwhile goal.

ALEXANDER: In regard to this latter suggestion, this morning I was wondering as Gene Torget stood up here at the board and compared the estimate that he got by his technique with the Census Bureau, with the Resources for the Future, and perhaps with other agencies - Why were they duplicating some of these computations? This is a question perhaps from a layman and someone who is ignorant of economics and how we're using this information. Talk about standardization - this reminded me again of it. Do we want standardization in our own method whereby we will go out and argue with someone else, or do we want standardization in all of these economic computations?

DAVIDSON: I think that we can safely agree on the idea that there are several ways to make economic forecasts, and certainly the recognition of the model approach or the use of the model approach is one way. A very valuable check on this, as Gene Torget so very well explained this morning, is to take the demographic approach toward population. I believe then that beyond that - beyond recognizing that here are two methods which can complement each other - it would be difficult to agree right now that we should take one or the other and use this as our standard from now on out. I think that in regard to comparing our work with the estimates of other agencies, we should recognize that usually we are concerned with a region, or a subbasin or an area, and there are estimates available from various agencies such as Resources for the Future, which were developed for the Nation, but were developed over a very short period of time. They were developed to give some over-all figure. These are useful guides. But I think that we have a different problem. We should, I'm sure, have the time or take the time to do a much more thorough type of analysis. If we disagree with projections made by other agencies, we want to look at why we disagree, but I think we have a somewhat different problem.

ALEXANDER: I'm still confused, frankly, because our figure for Dallas still disagrees with the Census Bureau figures for Dallas, and allegedly they are the federal experts on census.

DAVIDSON: I'd like to call upon the economist from Dallas.

TORGET: Their technique was - for projecting all the metropolitan area - and was very mechanical. I'm not saying that mine wasn't. But it was very mechanical, and in due respect to them, they would have looked a little more individually, but this was sort of a rush job, and what choice did they have? I know what they did and I certainly don't have any higher degree of confidence in what they did than what we did, so I'd rather stick with the one that I have come up with myself, not knowing of course, which is better.

DAVIDSON: Well, I might make a further comment about some of the census projections with which I am familiar. Oregon, for instance, has had projections made for it by the Census Bureau from time to time, and these are usually approached on a very mechanical basis. There are two ways of doing it. One is to take it merely as a fraction of the Nation and assume that it will continue to be the same fraction of the nation, or the other would be to extrapolate historical trends and typically the Census comes up with four estimates. And sometimes these are as far apart as the difference between 2 million and 1 million persons. These are merely to be used as guides. I don't think they're bad forecasts when I consider why they were done, and how they were done. They give us some guidance if we can ourselves pick out the specific range of conditions for the future. We can narrow this range down ourselves. This is a guide. The Resources for the Future approach projection is in much the same manner, as I understand. They picked a decade, and then said, well, things can't go on like this forever, we'll cut it by two-thirds. And from the very hasty analysis I made of Oregon, they happened to pick a time when Oregon was growing at an abnormal rate - they cut it by two-thirds, and they happened to be just right on the button, things by an entirely different procedure worked out to be just what they predicted. But if Oregon had not had an abnormal growth rate during their base period, they would have missed it a good bit. I don't criticize these. They are useful guides. I don't think we can use them as the last word for ourselves, but they are guides.

KRAUSE: I still have the feeling that much of this is dependent on professional judgment that comes as the result of long experience in dealing with these kinds of operations, the depth of which fellow professional workers in this particular field of projection, demography, and so forth, has brought us to the point where we are at the moment. There is some merit, I think, in the multiple approach to offer the guides that we may need in the future. When we come to attempting to pinpoint these forecasts for the future, if you have a series of professional people putting down their best judgment based on separate distinct approaches, and if you averaged all of these up, the chances are that you'd be pretty close to the right figure when the time came that you were making the forecast for. I think we need this judgment. We need this experience that is exhibited in the groups we have here before us. I would like to feel that it is not absolutely essential that we pick one method above all others to approach this thing; that perhaps amongst us we might agree on three or four approaches, and as Mr. Torget has expressed earlier, use these as checks and balances against judgmental factors which, in essence, represent only a best guess. I mean, I can put a figure on the board not knowing anything about analytical procedures for forecasting a 2010 population for the city of Dallas. I might hit it right on the head, purely a guess. But that guess might be backed up by some experience, professional judgment, which is somewhat inherent in a long period of experience in dealing with these problems. I feel that what we are seeing here is a methodology of how this experience is gained and how we will set it up. I really think that having the experience that we have in this room in this particular field is extremely important to our programs and the exact methodology for doing this, of course, among the researchers might be open to question. But none of us possess the clairvoyancy that would tell us the right answer 50 years from now. I do want to express my feelings that I think we are seeing here the approaches that professionals are making to this, and I am really delighted to see these many approaches presented and I have a feeling that any of you are in the best company in this business.

SCHREEDER: I wonder if any of the economists representing the Great Lakes Study or Southeast Study would care to comment at all on some of these approaches that were outlined here. I think you all have the same basic problems. You all make the same kind of studies.

KEHR: Speaking for the Great Lakes, I just want to say we don't have an economist - we're looking for one.

EICHBERGER: I feel the real issue is not so much one of having "a" particular model, or "a" particular method, or "a" particular approach, but does it take into consideration the real weighing of the factors that are involved that would lead us to a logical conclusion? We know that in this great United States of ours that there are tremendous variations in the regions, particularly when you get down to small areas. We are dealing with something here that we have to be pretty sure that the best judgment, taking into consideration pertinent factors, will lead to a logical conclusion. I don't know, Gene, if you will agree with me on this point or not, but I am a little bit skeptical about mathematical models. Mathematical models can become a little bit rigid. I'll go along with Jim, I think that anyone that works with this has a model, it may be a mathematical model, or it may be only a model in the professional mind that's doing the work, but he has some kind of a model that he's using as a tool for his approach. So I am just a little bit skeptical about models, because I'm afraid they do not allow in all cases, at least, enough flexibility that will take into consideration the judgment factors that are always involved. Economics is not a mathematical science. In certain areas this can be done, but when someone deals with such things as human an element as unemployment, we have to take into consideration the ups and downs of the economy and all the structural nature of our economy. These things vary so widely that the real important thing here is not so much a matter of standization - it's not so much a matter of whether we have aid from a model, but are we using the methods that we feel, that our organization feels will give us the answers that we want?

DAVIDSON: I think that statement by Bill would cause me to change one of my conclusions. I've jotted down a statement which might be better. "Model is useful when it makes you think, but loses its usefulness when it replaces the thought process."

EICHBERGER: I'll go along with that, absolutely.

LOCATION FACTORS

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Introduction

Industry in the United States is moving. Due to the competitive nature of our enterprise system, a careful analysis must be made by any manufacturing establishment before a new location is selected. In making this analysis many factors must be evaluated, particularly those that vary significantly from area to area. The objective is the determination of that area in which the product can be manufactured and delivered to market at the lowest total cost.

There are many location factors to be considered in choosing a location for an industrial plant. The factors may be classified as (A) essential, (B) important, or (C) to be considered. The distinction between these categories is important. Essential requirements are those necessary if the plant is to operate profitably. Important factors are those which will increase the margin of profit but do not have the significance of the first category. Factors to be considered add to the attractiveness of the site and may have some bearing on profits.

There are 18 or more plant location factors recognized by authorities in the field to be analyzed in choosing a location for an industrial plant. Arranged in alphabetical order these are:

Buildings
Climate
Distribution Facilities
Financial Help
Fuel
Labor
Laws and Regulations
Living Conditions
Market
Power
Raw Materials
Services (Equipment and Maintenance)
Site
Supplies
Taxes
Transportation
Waste Disposal
Water

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The author wishes to express his appreciation for the cooperation and assistance of the Texas Engineering Experiment Station, College Station, Texas.

The general locality is selected on the basis of the essential and important requirements to an industry, such as the availability of raw materials, markets and transportation facilities. Essentiality and importance will vary from one industry to another. "Factors to be considered" may help to determine the specific community within this general area. For example, pleasant living conditions are an advantage in locating most concerns. An agreeable climate and recreational facilities are helpful in obtaining high-class personnel. Some communities may have high land values and taxes, local ordinances, or community attitudes which would discourage industry. Other communities may offer inducements such as free or low-cost land, lower taxes, and financial grants.

Before a building site is selected, an engineering study should be made. This consists of a terrain study, including analysis of structural foundations and drainage conditions. In regard to water supply, the ground and surface water should be determined and the quality established.

Though it is hazardous to generalize on the locational economic factors of industries comprising broad categories, nevertheless, the following attributes may be accepted as characteristic.

This report will discuss locational factors of the following industrial categories which have heavy water requirements: (1) pulp and paper; (2) petroleum refining; (3) chemicals; and (4) iron and steel. Each is examined individually to determine its particular site requirements.

A study of the Texas Engineering Experiment Station illustrates the application of locational factors by the first three of the abovementioned industries. This study is reviewed in the final portion of this paper.

Pulp and Paper Industry

The pulp and paper category is one of the largest and fastest growing industries in the United States. In the four-year span, 1954-1958, value of shipments increased from $3,769,700,000 to $4,769,772,000, or approximately 27 per cent. 1/ The United States per capita paper consumption increased from 58.0 pounds in 1899 to 200.6 pounds in 1930, to 382.5 pounds in 1950, and to 437.0 pounds in 1959. 1/

Pulp and paper mills are located in the New England-New York area, the Southeastern States, the West Coast and the Lake States. Essential factors governing the location of these mills are the availability of fibrous raw materials, an abundant supply of good water, good transportation facilities, ample power supply or sources of power, and waste disposal capability. Important factors are proximity to markets and an adequate labor supply. Factors to be considered are general living conditions, local ordinances, taxes, and the attitude of local authorities and the community.

Essential Requirements

The most important of all the factors listed is the availability of fibrous raw materials. Before the introduction of wood pulp, paper manufacturers used straw for wrapping paper, board and some printing papers, and rags for writing papers. In 1880, of a total of 619,682 tons of raw materials, approximately 40 per cent was straw; 29 per cent, rags; 16 per cent, old paper; and 15 per cent, manila stock. Rags were obtained from American cities which also supplied the markets for finished products; thus, Massachusetts, New York, Pennsylvania and Connecticut, in that order, led in the production of paper. 1/

When wood pulp came into use, the industry spread farther into the New England states, which were richly endowed with spruce and fir. As these supplies became depleted, however, the wood pulp output shifted westward and southward.

The South is becoming increasingly important to the pulp and paper industry and contains 40 to 45 per cent of the commercial timber of the nation. 1/ The southern pine grows to the optimum height in 25 or 35 years, which is two or three times the rate of most northern species. It has very few limbs and knots, and extremely long fibers, which make it desirable. The development of the sulfate (kraft) process made the southern pine more usable for strong paper.

Until the late 1930's, attempts to use the southern pine for newsprint were unsuccessful. Grinding stones were easily fouled; high resin and pitch content fouled machines; and paper was marred by stains, holes and slime spots. However, adaptations were made in grinding stones, while chemicals solved the problems of "blue stain" (a fungus), slime, pitch and resin. Despite this, newsprint production did not move south until the weak price situation of the depression years was corrected. Even then, first attempts were financed in part by newspaper publishers and in part by the Reconstruction Finance Corporation.

Although much of the Nation's paperboard is made of waste paper, an increasing share in recent years has come from the kraft process. For any given strength, kraft is extremely light and, for any given weight, it is extremely strong. In 1925, only 20,700 tons of kraft paperboard were produced (0.7 per cent of the total); in 1956, the figure had risen to 5,971,000 tons (41.6 per cent of the total). 1/

The following figures on total wood pulp capacity show that the increases in output in the South are greater than elsewhere, although production in other areas has not declined.

Wood Pulp Production [1]

(Thousands of Tons)

Year	New England	Middle Atlantic	Lake	West	South	Total
1946	1,592	1,039	1,726	2,058	5,715	12,130
1947	1,605	1,143	1,842	2,175	6,024	12,789
1951	1,818	1,259	2,230	3,140	9,221	17,668
1952	1,910	1,316	2,316	3,303	9,928	18,771
1956	2,183	1,364	2,608	4,470	13,026	23,650
1957	2,197	1,531	2,658	4,654	13,891	24,931
1958	2,260	1,531	2,680	4,825	15,102	26,398

Throughout the pulp process, pulp is handled in water suspensions varying in consistency from 0.5 to 30 per cent solids, which means about 3 to 200 times as much water (by weight) as pulp. [2] The suspension fed to the forming part of the machine usually contains one-half pound of pulp to 99.5 pounds of water. Water is recirculated and reused whenever possible, in order to recover all the raw material (fibers) in suspension, but the over-all consumption may be anywhere from 25,000 to 100,000 gallons per ton of finished paper. [3] The amount is dependent upon the type of paper produced and the process used.

The water should be clean, of good color (if white papers are being made), low in chlorides and free of excessive amounts of dissolved solids. The supply must be adequate the year round. Most mills rely on surface streams or lakes, but some obtain their water from wells. Approximately 78 per cent of all pulp and paper mills use surface water and 22 per cent use ground water. [4]

In the North, streams have been used for carrying raw materials to the pulp and paper mills. Today, this method has been replaced by trucks or rail, as many mills find it necessary to go greater distances for their supply. In the South, rail and trucks are commonly used for transporting the raw materials. The reason why streams are not used is an interesting one - the southern pine pulp wood is too heavy and sinks in water.

Barges carry a sizable proportion of raw materials and finished products. Most of the larger mills are located on navigable waterways (e.g., Champion's Pasadena, Texas, mill on the Houston Ship Canal; Bowaters Southern at the confluence of the Hiwassee and Tennessee Rivers; Rome Kraft and Coosa River on the Coosa-Alabama River system; Union Bag Camp on the Savannah; Macon Kraft on the Okmulgee). [1]

Pulp and paper mills depend heavily on transportation facilities. For efficient operation, replacement machine parts must be delivered quickly. In this case the time element is extremely vital. Therefore, the highway net and rail connections are significant.

Fuel for power generation is an essential factor to the pulp and paper industry. Many mills have their own turbines or generators to supply all or part of the power needed. In fact, the industry ranks first among all industries in generating power for its own use and seventh as a purchaser of power, and is in third place (outranked only by chemicals and by iron and steel) as a consumer of industrial power. 1/

Chemical recovery is high in the paper industry. At present, recovery systems are especially effective at the digester area, averaging around 90 per cent. However, the waste disposal problem continues to be enormous and must be solved if the industry is to grow. On several occasions, accidental releases of cooking liquors have resulted in fish "kills" in receiving streams. 1/

Color is the most objectionable characteristic of most paper mill wastes. To date no economically feasible method has been developed to remove color from the large volumes of wash water which constitute the major portion of wastes from this industry. Satisfactory disposal of these wastes can only be accomplished by dilution with color-free water, which means that pulp mills must locate near rivers and streams with sufficiently large flows to accept and dilute the colored wastes to a point that they present no further problem. The number of mill sites with water flows adequate to provide satisfactory dilution of treated wastes is becoming scarce.

Important Factors

Proximity to market is an important factor, simply because paper and paper products are low-value-per-ton products on which freight rates are quite high. The general rule is that plants tend to locate where total transfer costs of moving raw materials and products to market are lowest. Companies depending on waste paper as a raw material have no problem in this respect, since the source of supply and market are usually in the same general area.

An adequate labor supply is necessary to the industry, but is not generally a problem. In pulp mills the number of workers per unit of product is comparatively low and few skilled workers are required. When the announcement was made that the Bowaters mill was to be built in Calhoun, Tennessee, in 1953, people from 200 miles away sent in applications. With about 800 jobs available, the industrial relations manager received some 20,000 applications. 1/

Factors to be Considered

Factors to be considered are general living conditions, local ordinances, taxes and the attitude of the community and the local authorities.

Petroleum Refining

In 1957, the petroleum industry produced an average of 7,169,000 barrels of crude oil daily. 5/ The per capita consumption of petroleum in the United States has increased from 7.5 barrels in 1929 to 10.1 barrels in 1939, to 14.1 barrels in 1950, and to 20.1 barrels in 1960.5/ The following table shows that the contribution of petroleum to the total energy consumed (as compared to other energy sources such as coal, natural gas, and water power) has increased spectacularly, especially between 1917 and 1927.

Energy Sources in the United States 5,6/
(In Per Cent of Total Consumption - BTU Basis)

	1917	1927	1937	1947	1957
Coal	82.8	67.1	54.0	50.7	*
Petroleum	9.8	23.8	32.7	33.7	40.5
Natural Gas	4.0	5.8	9.7	11.6	*
Water Power	3.4	3.3	3.6	4.0	*

* Data unavailable

Petroleum refineries are generally located at or near producing wells, at trans-shipment points or in areas of heavy consumption. Essential requirements are markets, transportation, availability of raw materials, water, and waste disposal capabilities. Important requirements are fuel and power, and sites. Factors to be considered are living conditions, laws and taxes.

Essential Requirements

There is a slight tendency to erect new refineries where markets are assured, due to the growing dependence on crude imports. The vast system of pipelines for transporting crude oils has facilitated the market location as evidenced by petroleum refining districts on the Great Lakes between Chicago and Cleveland, and on the Atlantic Coast between Baltimore and New York, rather than near the major oil fields.

Transportation costs of crude oil and refined products play an important part in the profitability of refining operations. Crude oil is transported from the oil fields to the refineries by pipelines, tankers, tank cars or trucks. Normally the cheapest mode is by oil tanker; it costs two and one-half cents to transport one barrel of crude oil 100 miles.[17] Consequently, many refineries have located in coastal areas accessible to tanker transportation for movements of either crude oil or finished products, including foreign imports.

About 75 per cent of the crude oil received at refineries is transported by pipeline at some time. In 1958, the United States had a pipeline network in excess of 160,000 miles serving the petroleum industry. Costs of overland transportation by pipeline vary, but generally they average about three cents or more per barrel of crude oil per hundred miles. [8]

Rail and truck facilities are not competitive with tankers or pipelines. These forms are used to a limited extent in new fields where no pipelines are available or in small fields where production volumes do not justify pipeline construction.

Petroleum refineries in the past have often located near major oil fields. Although some refineries may still do so, it is becoming less common, since it becomes uneconomical when production falls off at any single field.

An adequate water supply is essential to the location of a petroleum refinery. The conversion of gases into products requires from 0.8 to 44.5 gallons of water for each gallon of crude oil processed. Since the breaking up of crude oil into its products is a conversion of high thermal efficiency, almost 97 per cent of the water is used for cooling. [3]

Adequate waste disposal facilities are a necessity. During the processing of the crude oil, the effluent is run through settling ponds or tanks to collect waste oil and avoid pollution. If the effluent has accumulated harmful chemicals, it may also be treated to eliminate them. If the water supply is limited, water may be retained and cooled in ponds or towers for reuse.

Important Factors

The rates of electrical power may be significant. A refinery requiring a great amount of power may find it more economical to build its own power plant than to purchase utility company power.

Refinery equipment is extremely large and heavy. Therefore, it is very important that the soil in any selected location be able to support exceptionally heavy loads.

Factors to be Considered

Factors to be considered are living conditions, laws and taxes.

Chemical Industry

The importance of chemical industry can best be illustrated by the increasing value of sales of chemical and allied products from 1939 to 1958.[9] In 1939 the sales were $4,339,000,000 and increased at a steady rate to $23,219,000,000 in 1958. The value added by manufacture from 1939 to 1957 increased from $1,818,941,000 to $12,116,000,000. The dynamic growth of this industry has always been one of its outstanding features.[9]

The chemical industry is broken up into two branches, organic and inorganic. Organic chemicals are defined as compounds which, like plant and animal matter, contain the very prevalent carbon atom. These are derived from residues of prehistoric life, such as coal, petroleum and natural gas, or from the present day materials of life, such as agricultural products. More than 2,500 chemical products come from petroleum and natural gas alone. Chemicals from these two products accounted for around 57 per cent of the dollar value of all U.S. chemicals in 1959. More than half of them ended up in such products as fibers, plastics, fertilizers, elastomers and synthetic rubber. The organic chemicals account for the largest number of industry's products.[9]

Compounds that do not contain the carbon atom, but are obtained from such things as atmospheric gases, water and minerals, are inorganic compounds. For example, salt is used to produce chlorine, caustic soda, bleaches and soda ash; sulfur is used for sulfuric acid; and nitrogen and oxygen are used for ammonia, nitric acid and oxygen production.

In general, location factors follow the same pattern for all companies producing basic chemicals. For the purpose of this report, the two divisions will be treated as one unit, with greater emphasis on the petrochemical industry.

The geographic location of a chemical plant depends largely on the essential factors: availability of raw materials; low-cost fuel and power; inexpensive transportation facilities; proximity to markets; water and waste disposal capabilities; and the availability of good quality labor. An important factor is proximity to other supplies and maintenance service. Factors to be considered are regulatory laws and practices, taxes, and living conditions.

Essential Requirements

Chemical manufacturers use a variety of raw materials, such as coal, petroleum, air, water and minerals. The minerals include such materials as sulfur, salts, sand, clay, lead, zinc, copper, iron, boron and aluminum. Plants which require sea water must naturally locate on the coast. The abundance of coal makes the West Virginia-

Pennsylvania area particularly desirable for some organic chemical producers, while the abundance of petroleum makes the Gulf Coast extremely desirable for the petrochemical industry. Sulfur is obtained from underground deposits in Texas and Louisiana; salt from brine wells and mines in Michigan, New York, Ohio, Louisiana and Texas, as well as from solar evaporation of sea water in California and from Great Salt Lake, Utah; phosphate rock from Florida, Tennessee and the Rocky Mountains; and potash from New Mexico, California and Utah. The following list of the top ten states in chemical construction illustrates the importance of the availability of raw materials to the petrochemical industry.

TOP TEN STATES IN CHEMICAL CONSTRUCTION
(1958 MCA Construction Survey)

	(In Thousands)
Texas	$662,323
Louisiana	473,200
California	144,710
Tennessee	142,576
West Virginia	136,650
Ohio	134,900
Pennsylvania	127,190
New Jersey	117,114
Illinois	114,850
Florida	113,625

The availability of low-cost and abundant fuel and power is influential in locating a chemical plant. Many have located in certain areas where raw materials, such as coal, petroleum and natural gas are present, and these raw materials can also be used as inexpensive sources of fuel and power.

Low-cost transportation facilities are important to the chemical industry. The lack of inexpensive modes of transportation has hindered the establishment of chemical plants in some areas. The cost of transporting raw materials and the finished product must be compared when determining a suitable location. If the packaged product has a higher freight rate, it is probably more economical to locate near the market and ship raw materials.

In 1954, the chemical industry, one of the Nation's major water-using industries, used 24 per cent of the total industrial water intake, or 2,827 billion gallons.[3] The greater percentage of this water is used for cooling. To produce 100 pounds of ascorbic acid, for example, requires 85,000 gallons of water; to produce 100 pounds of bromine requires 250,000 gallons of water. This stresses the need for an adequate water supply in the selection of a chemical site. 2/

The number of suitable sites with good quality water supplies is decreasing, because in many instances municipal and industrial wastes receive inadequate treatment prior to discharge and cause serious degradation of receiving streams into which they are released. Since these streams are often the only source of water for potential industrial development downstream, the number of industries that can use the lower quality water is limited. Closer attention is being focused on this situation. More stringent laws are being passed and stricter enforcement of existing legislation is resulting in the improvement of conditions that have plagued entire river basins for decades. New industrial plants are active in the development of the most advanced equipment for pollution abatement or avoidance procedures. In some areas, strict waste disposal regulations are imposed on chemical plants. This is especially true on the Ohio River from Pittsburgh to Cincinnati; the Delaware River from Phillipsburg to the Delaware Bay; the Susquehanna River from Harrisburg to Chesapeake Bay; Lake Erie near Cleveland; and the Houston Ship Canal.

As in the petroleum industry, markets are becoming increasingly important. Nearness to markets and supplies are especially important if water transportation is unavailable.

Many skilled and technical workers are needed in the chemical industry. Of a total of 846,400 employees in May 1959, over 60 per cent are production workers, many of whom are highly skilled. Administrative, scientific, sales and executive positions make up the remainder. The largest part of the plant workers are process workers, who operate chemical and mechanical equipment. Because of the highly technical and varied nature of the industry's operations and products, it is often necessary for employees in administrative, purchasing, sales or legal capacities to have scientific or engineering backgrounds. 9/

Important Factors

Nearness to supplies and maintenance services are important in selecting a location. The direction of prevailing winds, which may carry objectionable odors to the surrounding areas, must certainly be appraised in this type of operation.

Factors to be Considered

Factors to be considered include land values, local ordinances, zoning, homes for workers and community attitudes.

Iron and Steel Industry

The iron and steel industry in the United States is basic to the Nation's economy and to its standard of living. Spreading to all four corners of the country, steel producing facilities are located in 31 states. They are concentrated in Pennsylvania, Ohio, Indiana and Illinois, which have 27 per cent, 20 per cent, 12 per cent and 9 per cent of the Nation's output, respectively. The others have considerably less. [2]

The essential requirements for this industry are the availability of raw materials, markets, transportation, water, fuel, waste disposal, and labor. Important requirements are maintenance and service facilities. Factors to be considered are living conditions, taxes, and local laws.

Essential Requirements

Of the essential requirements, the availability of raw materials, particularly ore, coal and limestone, has probably played the most important part in determining the steel-making centers of the United States.

For every ton of pig iron produced, three to four tons of raw materials are needed. High quality iron ore deposits are found in northern Minnesota and Michigan. The value of iron ore extraction in Minnesota ranged between $350,000,000 and $550,000,000 annually between 1951 and 1957. [5] In Michigan, the value ranged between $75,000,000 and $105,000,000 annually during the same period. [5] Ninety per cent of all the coal mined in the United States is mined in Pennsylvania, Ohio, Indiana, Illinois, Virginia, West Virginia and Kentucky. Rich limestone deposits are found in Michigan, Pennsylvania and Ohio. Because of the geographical separation of these areas, one or more of the raw materials must be transported by rail, water, or both. Since coal is lighter and takes up more room than iron ore, it is generally more economical to locate mills closer to the coal supplies than to the iron ore mines, even though the quantity of iron ore required in the process is greater than the coal. However, in some cases coal is moved to the ore, and in others both are moved to a junction point. Before the utilization of electric power in the industry, steel-making facilities also depended on the coal fields as a source of power.

Many steel plants, as previously mentioned, have concentrated in certain parts of Illinois, Indiana, Ohio, Pennsylvania, New York and West Virginia. The raw materials are relatively accessible from these areas, since the Great Lakes provide a convenient means of transportation.

The proximity of steel-producing centers to the market is another essential factor. A densely populated territory or a general industrial area is often a good location since scrap iron, which can be used as a raw material, and markets are both available. Plants located on the Atlantic Coast can readily receive foreign iron ore supplies from Venezuela and Labrador-Quebec and in turn can supply the Eastern market with steel and steel products.

The presence of raw materials and the nearness of markets have led to the establishment of steel mills in the Birmingham, Alabama, region. This area has substantial deposits of iron ore, coal and limestone, which are closer together than in any other area of the United States. Lone Star Steel located in Daingerfield, Texas, because this area has deposits of iron ore and limestone and transports coal from nearby Oklahoma. Located in one of the richest oil fields in the world, Lone Star produces iron casings, drills and other related products to supply the available market. 10/

Economical transportation is an essential requirement to this industry. Its raw materials, and most of its products, have a low unit value in proportion to their weight. Without low-cost convenient transportation, production costs would rise enormously and make steel a less economical product.

The industry transports its finished product by rail, truck or water. Water transportation, however, is used whenever possible, as it is most economical.

Water is extremely important to the iron and steel industry. It is used in a number of ways, particularly for cooling blast furnaces. A furnace with a capacity of 1,000 tons of iron a day used from 1,400 to 65,000 gallons of water in 24 hours. 3/ Approximately 80 per cent of the water used is reused, and only leakage and evaporation losses of some 15 per cent must be made up. 2/

Most types of fuel, including coal, coke, gases, fuel oil, natural gas and electricity, are used in steel production. However, within the last ten years the industry has become one of the country's top consumers of electricity.

Stream pollution arising from the extensive operations of the iron and steel industries has produced a need for adequate waste disposal capabilities. The most objectionable characteristic of the wastes is the suspended solids, which are mainly particles of ore and coke. Some of these solids settle readily and form a coating on the bottom of the lake or river. These deposits are destructive to bottom organisms which are an important source of fish foods. The suspended solids also add a deep gray or black appearance to the water, making it unsatisfactory for recreational uses and aesthetic conditions. 11/

Phenols and cyanides may also be present in the wastes. These chemicals not only are toxic to aquatic life, but can be a menace to public water supplies and bathing facilities. Therefore, a suitable means for disposing of waste water from iron and steel mills is a necessity. 11/

Steel mills require the service of men skilled not only in steel-making processes, but in many other lines. About 1,200 separate and distinct jobs are to be found in the plants and offices of the iron and steel industries. 2/

Important Factors

Maintenance and service facilities are important to this industry.

Factors to be Considered

Living conditions, taxes and local laws are factors to be considered.

Plant Location Factors in Texas

The significance of the many factors which influence the location of new plants, mills and factories in Texas has been brought out by the Texas Engineering Experiment Station in a report entitled An Evaluation of Plant Location Factors in Texas.

Questionnaires were sent to 850 manufacturers throughout the State. These manufacturers were to indicate, in order of importance, the five basic reasons for the location of their establishments. Three hundred and fifty questionnaires were selected and classified according to the Standard Industrial Classification List into 14 groups. The industrial groups, number of returns in each group, and percentage of total in the State are shown below. Iron and steel firms were omitted in this survey.

Industry Group	No. of Returns	Per Cent of Total in State
1. Food & kindred products	38	3.5
2. Textile mill products	10	17.2
3. Apparel products	22	7.7
4. Nonapparel textile products	8	12.9
5. Lumber and wood products (except furniture)	22	3.3
6. Furniture and fixtures	19	8.7
7. Paper products	13	27.0
8. Chemicals and allied products	41	15.1

	Industry Group contd.	No. of Returns	Per Cent of Total in State
9.	Petroleum products	11	11.7
10.	Rubber products	13	81.2
11.	Stone, glass and clay products	28	13.3
12.	Fabricated metals (except machinery and transportation equipment)	66	25.5
13.	Machinery (except electrical)	31	8.7
14.	Miscellaneous	28	21.2
	TOTAL	350	7.8

To obtain the relative weight, each locational factor was tabulated according to the position assigned it by the respondent firms. A factor in first position was given a value of five; those in following positions were given values of four, three, two and one, respectively.

Results of the survey are shown in the following figures by industrial categories.

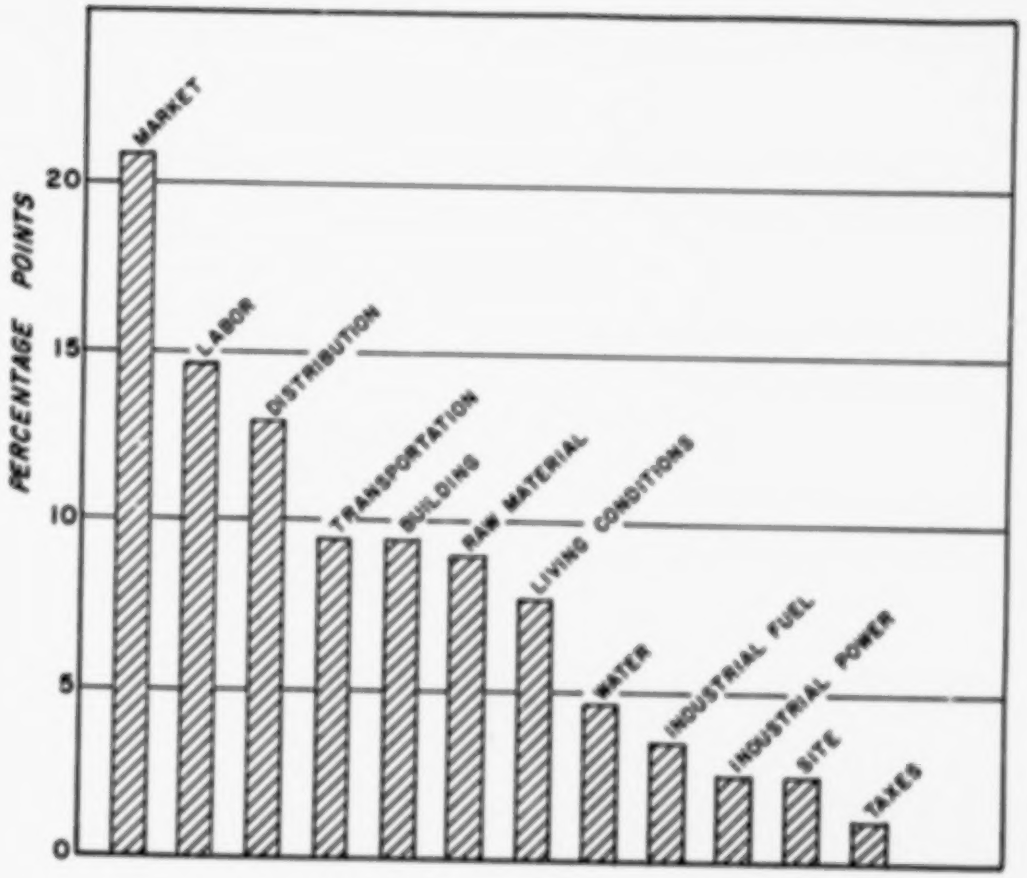
The paper and paper products industries in Texas are primarily concerned with markets, and labor and distribution facilities. See Figure 1. Since the pulp industries are not considered, raw materials, transportation and water are rated lower than they would normally be in the pulp and paper industry.

The importance of raw materials, transportation and markets is revealed in the eleven returns of the petroleum products industry. See Figure 2.

The chemical industry has developed in Texas in recent years because of the availability of raw materials, presence of a growing market and good transportation facilities. See Figure 3.

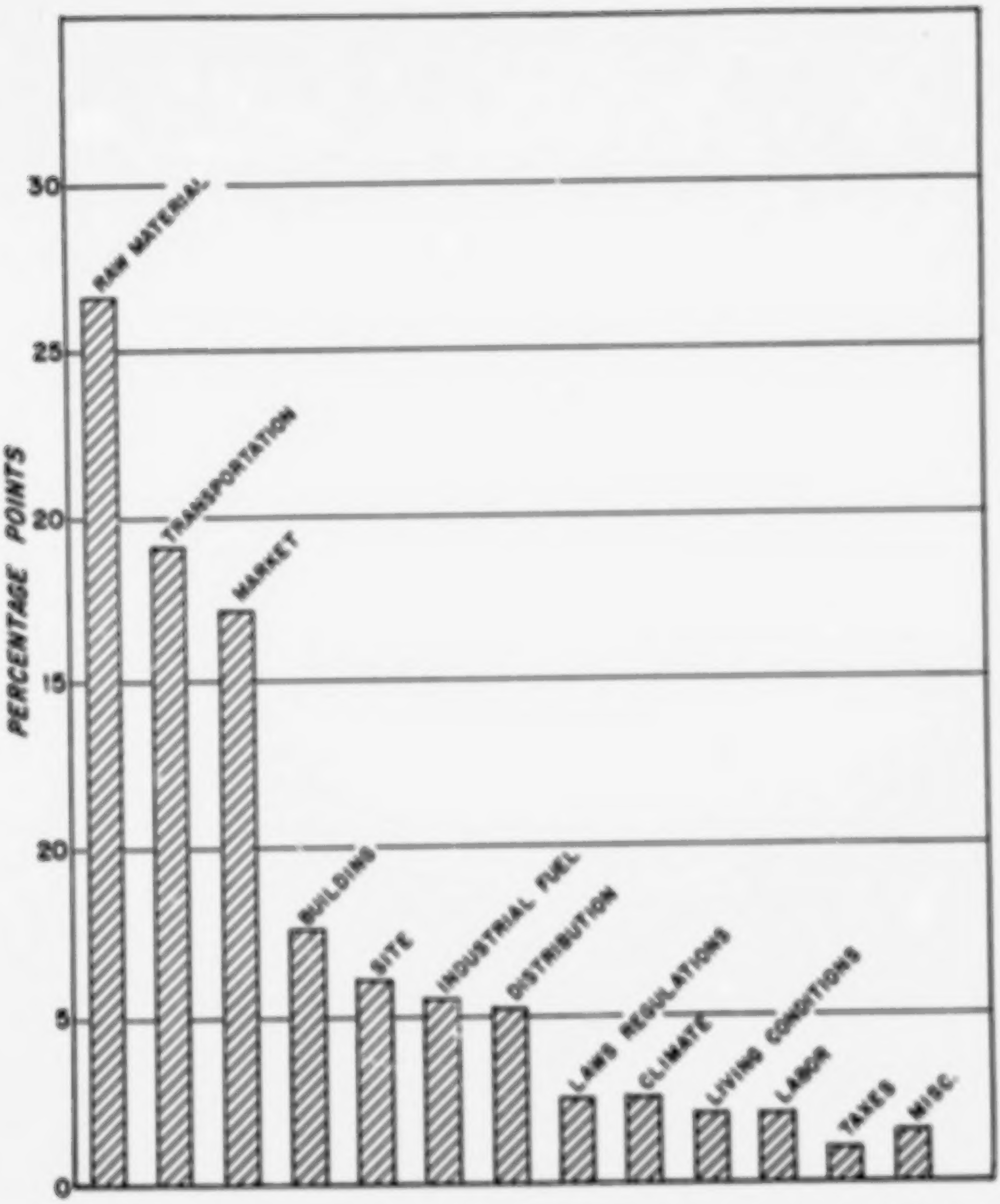
It is apparent that when all industries of Texas are considered, market, labor and raw materials are the three most important location factors. Water is of minor importance in the location of an industry within this State. Waste disposal capabilities was not on the list of factors. See Figure 4.

98 b



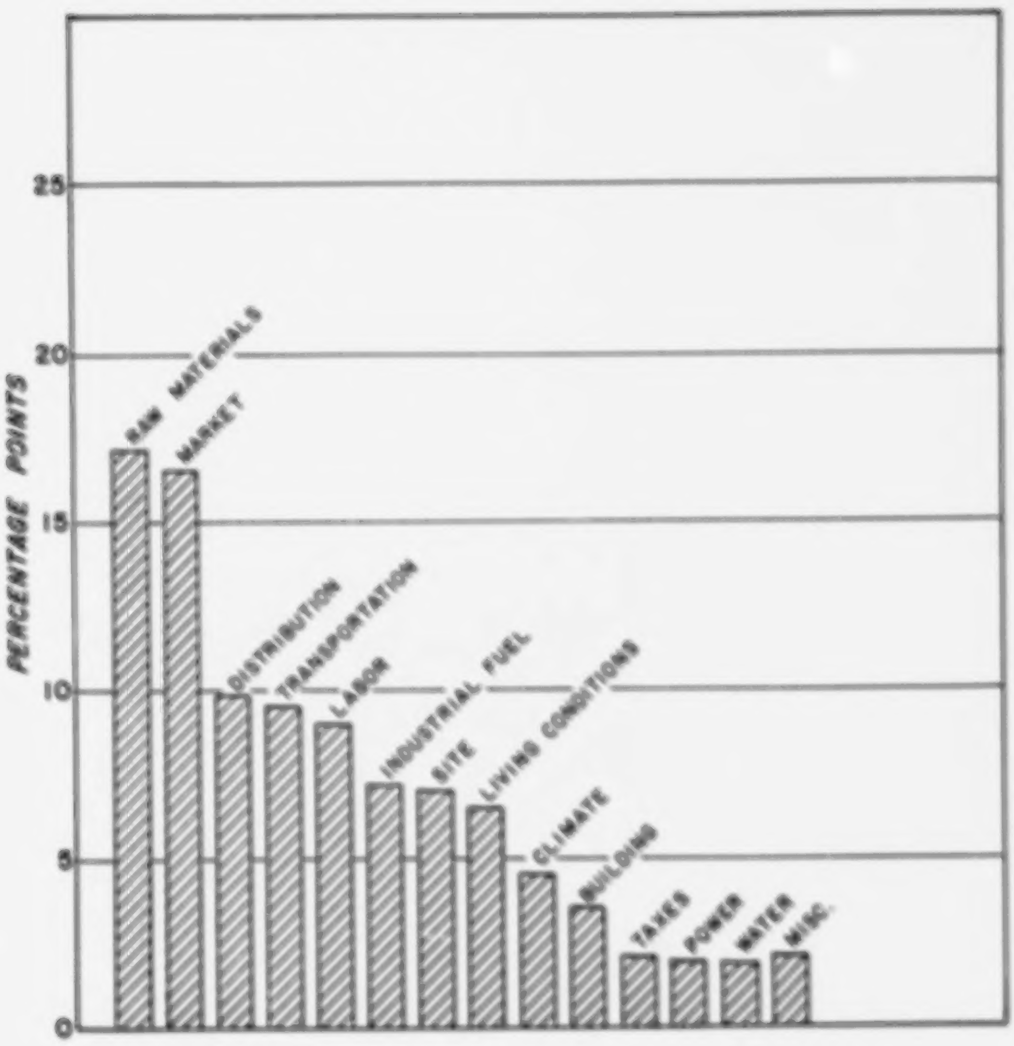
LOCATION FACTORS IN THE PAPER PRODUCTS INDUSTRY

FIGURE 1



LOCATION FACTORS IN THE PETROLEUM PRODUCTS INDUSTRY

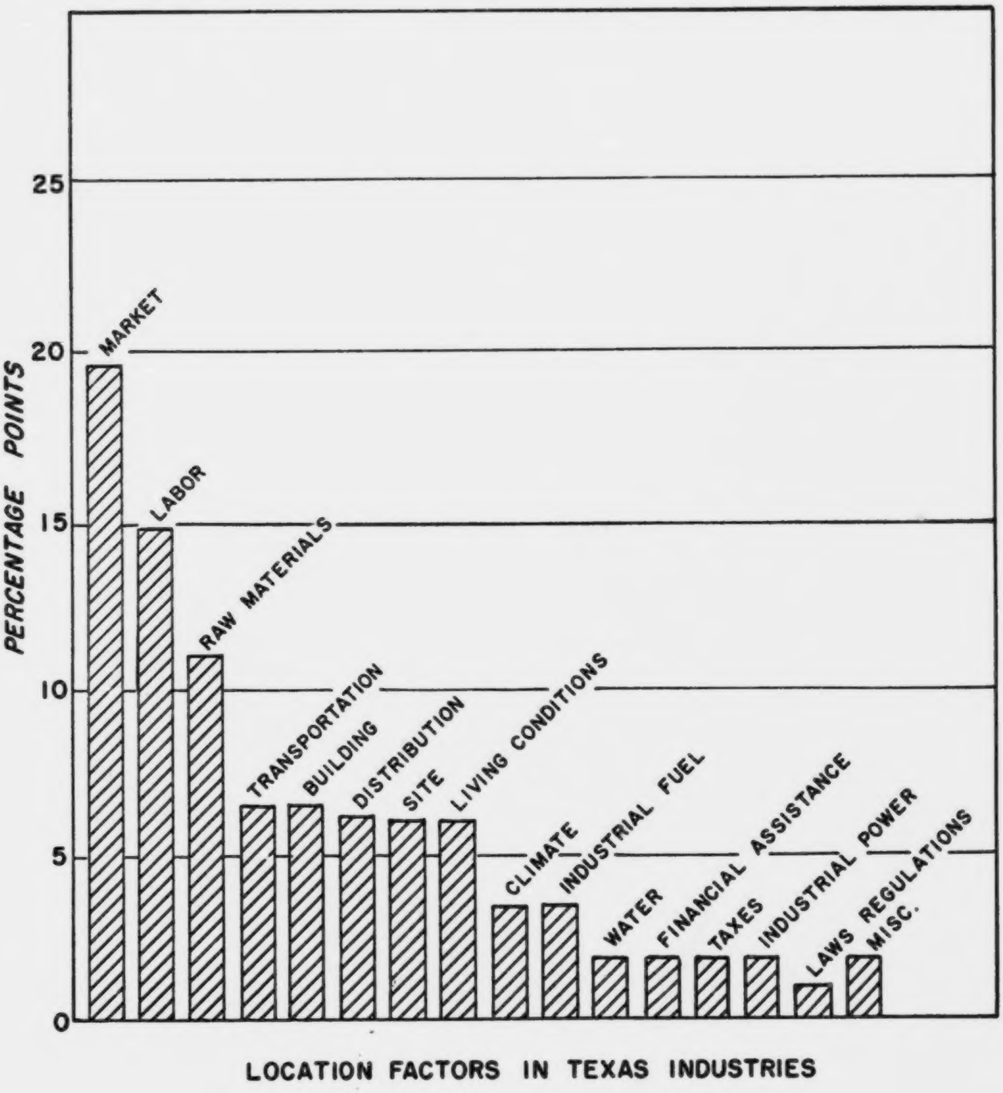
FIGURE 2



LOCATION FACTORS IN THE CHEMICAL INDUSTRY

FIGURE 3

98e



PERCENTAGE POINTS
25
20
15
10
5
0
MARKET
LABOR
RAW MATERIALS
TRANSPORTATION
BUILDING
DISTRIBUTION
SITE
LIVING CONDITIONS
CLIMATE
INDUSTRIAL FUEL
WATER
FINANCIAL ASSISTANCE
TAXES
INDUSTRIAL POWER
LAWS REGULATIONS
MISC.
LOCATION FACTORS IN TEXAS INDUSTRIES

FIGURE 4

CONCLUSIONS

1. Economic theory of industrial location is based on the maximization of the investment situation as determined by the profit margin; that is, achievement of the widest spread possible between cost and income or revenue.

2. Seldom does one factor alone play the decisive part in determining a plant location. A combination of factors which will bring the greatest monetary returns will govern the choice of the site.

3. Heavy water-using industries are generally located near their source of raw materials, because their kind of process generally involves bulky and costly-to-move raw materials, as compared to the finished products.

4. An adequate water supply is essential for all industries, but it is only when all other factors are equal among several locations that abundant and cheap water plays a decisive role in industrial location. Factors such as the availability of raw materials, proximity to markets and inexpensive transportation must be present in conjunction with the water or the site is infeasible.

5. Heavy water use means large volumes of liquid waste with attendant problems of satisfactory disposal. Sites with adequate waste disposal capabilities for the heavy water-using industries are becoming scarce. With strict regulations against pollution, the problem is still present. Therefore, waste disposal is a significant factor in locating an industry.

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DISCUSSION

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This certainly provides a comprehensive and well organized analysis of industrial location factors. There is no question that water resource planners must be concerned with the factors which move industrial titans. Further, it is clear that these factors are not always apparent and that they frequently are not uniform. This situation calls to mind an incident involving the proverbial drunk and the proverbial hen-pecked husband: One bright sunny Saturday morning . . . .

Now, clearly, these fellows were not able to understand each others' motivations at this point and there seems to be times when we, as planners, cannot understand the apparent shortsightedness of industrial giants as they continue to pursue habits which from our "objective" vantage seem to be unwholesome for the community in the long range, or when communities themselves attempt to spawn such industrial types in spite of themselves. The most reliable approach seems to be to take the tangible factors which constitute a reflection of the "profit" motive and make our future estimates accordingly.

Now, I submit that there are other significant factors. Primarily, social responsibility and regulatory actions which are vague and seemingly impossible to measure but which play a decided role in our projections of future industrial patterns of water use and quality conditions. Further, as a crisis becomes enunciated in the area of water resources by various authorities, both technical and political, these factors rapidly increase in relative significance in the solution of the projected problems.

I wonder if these motivations have ever been examined. I wonder how these motivations could be examined. I think that they can be analyzed and eventually related to conventional factors. For example, I feel that interpretations placed upon such an analysis may help us determine the rate at which industrial leaders might be expected to subscribe to more uniform attitudes toward improved waste treatment or water re-use techniques. We may find that in reflecting this rate of sophistication we will significantly alter our traditional projections of thirsty industrial location and unit consumption.

In addition to raising the question as to how or if such an analysis could be pursued, I would like to inquire as to what extent civil defense considerations and attitudes, such as the present planning effort to decentralize industry or just to hide it, have or may be considered.

Finally, is it possible that entirely new concepts in transportation requirements and therefore market orientation may be evolving due to the expansion of traditional techniques such as canals and pipelines or due to development of the relatively new piggyback procedure or due to possible heavy loading of air transport with the advent of rocket power?

These are but a few of the questions which emerge after such a discussion. I am sure that there are many more.

GENERAL DISCUSSION

SCHREEDER: I think one conclusion we can come to on this particular subject is that there are not going to be any hard and fast series of factors which will all have the same importance. Those of you who read Time magazine may have noticed in a recent issue an expression of the political set-up in the State of Georgia County Unit System. As a refugee from Georgia, I am somewhat acquainted with that system - but what interested me was, here is a snapshot, or a picture of a town - you could fire a cannon down that main street; there wasn't anything down there. There was one little sentence in that whole article that said that a manufacturer had "cased the joint," as the terminology is, in an effort to put in a manufacturing plant, and the biggest factor that he ran into was that there wasn't any labor, so the plant wasn't located there. I think as some of these - as these two individuals have indicated, there are a great many instances where water doesn't have the importance we would like to ascribe to it. If we have enough water to drink - or as somebody said this morning, if there's beer available - this probably isn't going to be a particularly large factor. Do we have any comments from the floor on this?

SVORE: I don't know what the questionnaire looked like on these, Chuck, but in these conclusions that water was 'way down at the bottom of the totem pole, do you suppose this was because of past experience - the fact that they did not consider water in its light as a means of carrying away waste? I mean, they considered it as water, and not as a means for waste disposal. And that they were basing it on experiences during the past few decades and not what they're probably going to run into in the future if we do our job of water pollution control and states do their job the way they should.

HAJINIAN: I have a copy of the questionnaire at the office. They didn't have waste disposal on there, but if some way these manufacturing establishments thought of water as a means of getting rid of the waste, I'm sure it would be up high in these categories. Many of these questionnaires were sent to industries that have just been located. In other words, these aren't industries that have been there a long time, and I assume that water doesn't seem to be very important to them, or they haven't thought of it, anyway. This was my conclusion.

DAVIS: It's very interesting to note that water is 'way down in your list of factors. We wonder if water isn't in those raw materials. Is it possible that the water was in the raw material?

HAJINIAN: You mean water in the way of raw materials - you mean gallons of water for use - that they may have put the water supply in with raw materials? No.

DAVIS: Then the following question I would like to relate to that. Most of us recall back in 1954 we were in competition with the Department of Commerce in the defense mobilization effort. There was a great effort made by both these agencies and supposedly we came up with answers as to where industries could decentralize after the bombs - could we ship some of this business out, some of this manufacturing out - and it occurred to us that we wouldn't necessarily wait until we were bombed, but industry would look ahead and would locate where this water was in the smaller areas outside the areas of bombing. Did this show up at all?

HAJINIAN: This is true. There is decentralization, but not for these four heavy water-using industries. These four industries have to have these essential requirements or they can't locate at a given point. If all these other requirements are there, plus the water, all well and good, but they won't go there because of water.

DAVIS: Just to complete this particular phase, just what is the regulatory agency, or agencies, doing to look ahead and plan ahead - were they encouraged to put in bomb shelters - how about the production - isn't this being achieved at all?

CLARE: The Ozark regions in Missouri and Arkansas are wooded and to my knowledge in Missouri they have been developing production and it has reached the point where they feel that pulp and paper industry can be developed in and near the Ozarks. The Missouri Water Pollution Board was concerned about this, and they asked the Public Health Service to make a reconnaissance of the area to evaluate possible pulp mill sites from the standpoint of water supply and waste disposal. This was done. Incidentally, some of the streams on which mills of varying sizes might be located go into Arkansas. It appears that there are two or three streams in the area of southeastern Missouri to support pulp mills from the standpoint of raw materials as Chuck has outlined and from the standpoint of transportation, power, and water supply. The summary report on this reconnaissance is just out. We have a few copies in our office. If you would like to have a copy of the reconnaissance report, we'll be glad to supply it. These reports are similar to those written by the Public Health Service in northern Idaho and Montana a few years ago, and the Great River in Wyoming. So I think here's an example of a case where a regulatory agency was confronted with the problem and took action which, in our opinion, was very logical. Incidentally, they were opposed in this proposal that a reconnaissance be made by the State Forestry Department at first. However, the State agencies got together and the outcome was very satisfactory. In southeastern Missouri, I don't think they have enough pine or long-fiber woods (semi-hard woods) to use the kraft process. Another development that has occurred in connection with the iron and steel industry is the development of the taconite process in the iron mining areas in

Minnesota and Michigan. This process is a lower grade iron ore being pelletized and shipped to the steel mills, and it is my understanding that demand for this type of ore or raw material is now greater than for the high grade ore that used to be in demand. So these are things, examples of changes in process and changes in the use of raw materials, that we should have in mind and, also, an indication of the pulp and paper industry in southeastern Missouri where the regulatory agencies have recognized the problem and they have worked with other State agencies to try to find the logical answer.

NOBE: As water becomes scarcer and therefore becomes an economic in the real sense, I would propose that the importance in the location of water will become an increasingly important factor in industry location.

HAJINIAN: This may be true. However, Gene and I have had dealings with people. For example: I would ask, "Well, if you're short of water in the chemical industry, what would you do?" They said, "We would make our own source. We would convert sea water." And they would do all kinds of things. In other words, water is important, but they always come up with the same statements, like these other factors are much more important than water, and they very seldom consider water. Jack, you went through Daingerfield and perhaps you can briefly describe the steel mill there.

WITHEROW: They simply said they had all they needed. When I asked about future plans, they said as far as they were concerned they still had all the water they needed. I don't know whether they would be an ideal example of this type or not.

SMOUSE: He touched on one of the points I was thinking about. It strikes me that part of the reason that water is not considered as important at this time as it no doubt will be at a later date is because we have not quite reached the point where water is going to become critical. Some of these industries, as you say, will solve their own problems, but there will be new industries - there will be different industries develop that do have a relatively high water requirement and, when you reach the irreducible minimum, then you're going to have this become a major problem, and we are going to reach this point at some time down the road as our population increases and as our industry increases. I think it's a matter that, up to now, the cities have looked ahead - they have provided water for the industries themselves. This is one of the things we can't count on - looking to the future indefinitely.

DWORSKY: John just said what I was going to say. I thought all I would have to do would be to agree with him, but I think I still believe in the question of whether or not we are going to - I suggest that perhaps we've been overwhelmed by the newspaper publicity and the headlines and by the general statements that have applied. We have to look very hard to have a water problem. Certainly from industry's standpoint today, I don't myself see that they would have a water problem. I think essentially one of the reasons why this matter has never been of concern is that we're a water-rich Nation and there are many opportunities for them to locate wherever they want to, with plenty of water. And then I wonder if you finish by indicating the point that you mentioned to me a moment ago of Gilbert White's conclusion, because I think here lies the reason why I would take issue with the comment just before mine. I think that there's a long time ahead. We have many things that we can still do to take care of this problem.

HAJINIAN: I would like to comment on this. I think the way Gilbert White does. His theory is that, when water becomes scarce, he has definite proof that industries use less water. They use more conservation practices - they improve methods and use less water. And I agree with this point - I think they do this. All I'm saying is that these other essential factors are more important than water. I'm not saying they don't need water. All I say is that water alone is certainly no criterion for locating industry from what I found out.

HAGER: There was one point on this questionnaire where water was not important. The observation that seems obvious is that these were industries that located - they didn't have a questionnaire on industries that did not locate here. I cite just one case, in Arkansas, where Potlatch industries expended somewhere in the neighborhood of $10,000 in a region where they had vast forest holdings, this $10,000 being spent on a study to find out where in the world they could get some water to run a pulp mill. They didn't find any water, and they didn't locate a pulp mill in this area. Just for what it's worth, there is a case of an industry that would not show up on this questionnaire. They didn't locate here.

DWORSKY: Did they locate?

HAGER: No, they haven't located yet. They're sitting tight, because they have the holding here and they're just going to hold it. They're not going to locate here - I don't know where they're going to locate. They still own the forest region - they're going to use it differently for the moment. They're going to make table legs, or something. But if and when the particular region gets water (and we have a Title III study in this region), there are a number of other mills in the area that are also hot. Tomorrow morning I want to talk a little bit on this as a part of my presentation on water requirements in the boondocks, but I thought as long as we brought the pulp and paper industry up here, and we had this question of industry located filling out questionnaires - what about the ones that don't locate? How important was water to them? There was another case that I remember where an industry wanted to locate and they had phenol in their waste. The State Health Department jumped straight up in the air, because they were upstream from a waterworks. They expended a whale of a lot of money on waste treatment. Their treatment process was written up in all the journals about six years ago. But they wanted to put it there - they had to put it there - and they were willing to spend the money for waste treatment, even though the State Health Department really gave them a hard way to go. They had absorption, they had trickling filters, they had chlorine dioxide, and they had more treatment plant than they did industrial plant. So in this case, they went ahead anyway.

KRAUSE: I just wanted to ask Bob Haywood if he might not have a little something to say about this, having worked in site location, water supply and disposal. From inside of an industry experience, I wonder if he would want to comment.

HAYWOOD: I can cite instances going both ways. Let me get this thought out. Don't let's compare apples and oranges - established industries will spend money to protect their investment. As I said earlier today, they'll build cooling towers if they run short of water for once-through cooling. They'll go to air cooling if the economics indicate it. I know of one instance where an established plant spent a hundred thousand dollars to learn more about its future in the field of water resources - in other words, how much water would there be available. Why did they spend it? Because they were looking to that particular plant as a possible site for expansion. The unfortunate part of that - I guess it's human nature - about the time the time the one hundred thousand dollar study was concluded and the reports written, the drought ended and their interest declined rapidly. I know a site that's been held for 10 or 15 years. I've learned recently that it's now going to be put into use. Before they decided what type of operation was to go there, they again spent a sizable sum of money to investigate the availability of ground water. Fortunately, they had a choice. They could either go ground water or surface supply. They established that the ground water was not a good supply, so they've gone to surface supply. Most industries, you know, prefer ground water. I know a number of instances where plants have not been located in otherwise favorable sites because of the lack of stream capacity to assimilate waste without treatment or with reasonable degrees of treatment, and this I want to get into later on, not now. I don't think you can generalize - each tub has to rest on its own bottom. Each industry, each plant must be considered in light of the factors that apply. Industry has a latitude that municipalities do not have. I don't think there's any general answer to it.

FLANNERY: I think there's an aspect that's been overlooked. Water is the mitigating factor many times in the region of a particular locale. I think Leonard's point is very well taken - that industrial operations, seeking a location, may screen out several because of the limited capacity of streams, but the point is, on a national scale, if they go somewhere, the national economy has not lost. So we have here the conflict in viewpoint. If you're looking at the net effect on the national economy, we do not have a water crisis, but the net effect on the economy of a particular basin - this can be a net loss. And then you have to say, "Well, he's putting the money up - investing to produce this kind of activity." This is what you have reflected in economics all the time - the increase in the gross national product. Where you're looking at a regional economy, I think the judgment must come from the people - local money, local wealth that's going into this. Local wealth is not able to obtain an investment here - be regarded as a loss. But judged as a national water problem - I notice Mel Scheidt shaking his head - I think he will rebut me here.

SCHEIDT: I can't rebut you - I don't believe for the purposes that we are concerned here today that we are dealing with the national problem. Maybe I'm mistaken, but I'm under the impression that what we're concerned with is the problem of determining water demand in a given area as a part of the problem of justifying a water development.

FLANNERY: That's what I said, but consider whether it's a national crisis, whether we've lost anything in the national economy; it probably isn't so.

SCHEIDT: No, but the problem we have is not whether the industry is going to locate somewhere, but will it locate at this site? So, it's a local game.

FLANNERY: This is true if local money is making the investment. But, if the federal government is making the investment, the viewpoint must be a national one.

SCHEIDT: If we're going to get into a discussion of the problem of federal versus local reimbursement, then we've got something of a different problem at hand, and I think we'd better wait until we get there. But I was pitching my remarks entirely in the direction of this problem of industrial location from the point of view of the provision of the water in the local community for the industry on a reimbursable basis on the assumption that the industry, in turn, was going to pay its own cost of treating the waste that would be produced to the degree that federal money on a nonreimbursable basis will be involved.

HAJINIAN: I apologize for not following through on Dworsky's remark awhile ago. When I say water isn't important to many of these industries, here's some statistics I'd like to cite. One iron and steel industry that produced a hundred tons of iron a day uses 1,400 gallons of water. Another industry produces the same type of iron, 100 tons a day, uses 65,000 gallons of water a day. This is an example I think you wanted me to bring out. If water gets to the point where it's critical, these people will cut down on their water use.

I don't want to put this point across saying water is not needed. In fact, on every one of my industries, you will see that water is an essential factor. My only point is that water alone is not important enough to attract industry.

SCHEIDT: Just to back up a little what you said, Chuck, you know the specific location of the 1,400 gallons? That's Fontana where apparently it was sufficiently desirable to locate the steel plant in that area to warrant a very expensive treatment process.

HAJINIAN: That's right. That's my point. When water gets critical - when water gets to that point - other industries will do the same thing. I guess they're using sea water, and, if they're only using 1,400 gallons, why can't other industries?

SMOUSE: They covered the points in their discussion back and forth, I think. Basically, this group, as I see it, is going to set the policy. Either we're going to decide this from the viewpoint of federal funds on a national basis to locate for industry, or do we confine this to the area we're dealing with? And what will water do for the particular small area? And I think this is a basic policy that the people in this group are going to set, whether they want to or not, in writing an answer to the value of water in these reservoirs. This policy is going to be adopted one way or the other. In comment on your fact that industry will find ways of cutting down on their water, or making their own water, this is going to have a cost in itself. So, again, you'll have somewhere a meeting of the two. Is it cheaper to develop water in these projects, or for industry to reduce their water needs or increase their water supply by their own costs? I think this is a factor to be included that I thought about also.

EICHBERGER: There are two points I'd like to make. Professor White made a statement, "We do not know enough about the elasticity demand of water, nor do we know enough about the elasticity of the demand for water pollution control to reach any conclusions at this stage." And I think you'll find Gilbert does make that statment. Another point, I'd like to summarize here just a little bit - this industrial location in itself has done a magnificent job of trying out all the factors to be considered, but what are we shooting for? We're trying to come up with total water demand. When I first came in the Service just a year ago, I listened to Mr. Krause make a very excellent statement - one point where he showed you started to hit waters and came down where you have specific withdrawals and specific points and you have contaminants at specific points. I don't think we can lose sight of this now. An economist is faced with a terrific job. It isn't sufficient to say that you have these three sources or that you have these conditions that will attract industry in this general area. It seems to me that, particularly if we're working on a Title III project in a relatively small area, what we're confronted with here is where is this type of industry going to be located, how much water will it use, and what will its impact be on the pollution problem? This gets to be a pretty knotty problem. Listening to some of the people from the Southeast Study Commission recently, I got the impression that they were thinking in terms of the pollution problem by industry when they were talking about industrial location. Fifty years from now - and we're always thinking 50 years - how important is this particular pollution problem? Will we have the same type of problem 50 years hence we have today, or will industry actually clean up its waste? And is the seemingly terrific amount of water required for pollution, and so forth, is it going to be as important 50 years from now as it seems to be today? I don't know. These are some of the comments that we have to consider. I'm not sure, Jim, whether we're dealing here with a total national picture at this stage, or whether we're dealing with smaller segments - smaller areas. Certainly we're all concerned with Title III. Region VII has been in this now for a long time. When we get into such things as Title III we have - we almost have to pinpoint industry in order to determine the demands for water on a specific reservoir, and it seems to me we almost have to pinpoint to get at the impact of the pollution problem at that particular point. We have to know where these things are going to be located. These are some of the problems that the economist has when dealing with industrial location, because this, in turn, leads to employment and, in turn, finally to total population. They're all tied together. Now today we have talked about total population; we have talked about industrial or employment in basic industries, independent employment - now we're talking about industry - but actually, this becomes a part of the total complex, and this, I hope, we never lose sight of, because these things are tied together. We don't deal in segments. We're not dealing just with population as such; we're not dealing with employment as such; or location as such. But I defy anyone to separate those things. I don't think we can do that. I just wanted to throw this out. We're involved in something it seems to me that can only be dealt with comprehensively, and this to me is the real issue.

DWORSKY: I'm going to talk back to Mel only to the extent that I agree with him because I think we are basically talking in different frameworks - I think both of them are correct. The two most important things that seem to bear on the matter from my standpoint in terms of Mel's regional situation are the factors of the amounts of water needed if you want a dam back of the site for dilution of waste. It also doesn't matter for industry in the sense. I suggest that for the first, guidance is going to come from state policy and perhaps also federal policy, as Bill is going to indicate in his paper. I think here we're going to have a clear delineation of responsibility and requirements because, in the absence of any state decision, you have a range of no treatment and ultimate treatment. This will be a managerial responsibility, but we're deleting this managerial responsibility and making it a state policy. We tell them how much they're going to have to do, so state by state, area by area, this standard becomes more settled. In the matter of water supply for industrial use, this matter is not settled. I don't see it being settled in the future, because this will be a managerial decision. Industry will determine how much water it wants, how much water it wants as total water, as recirculated water, as fresh and brackish water combination, anyway they want to, and nothing that we can do is going to have an infringement upon that, except in one aspect, and that is the cost of the water that we are able to work into these projects. Even though we work in that cost to determine if industry is going to be there - because they have opportunities to undercut that cost if it's to their advantage. If it is not to their advantage, they'll use your water. All I'm saying here is that I don't know at this time how we can come to clear-cut decisions in terms of how much water we ought to seek in these reservoirs. On a logical basis there is no answer right now. There is an answer, but the answer hasn't been suggested before, and that answer is if you develop the sites to the maximum to provide for future anticipated requirements, and this is the only sure thing that we have - if we decided to utilize the site to less than its maximum, we say this is wasting the resource. Of course, others will come along and argue - I'm sure our economists can argue that there has to be some sort of past relationship to delimit it - but in the social area and speaking in terms only of the social good for the ultimate values, the site development to the maximum is implied. I haven't answered anything - these are just points.

SVORE: Along this line of what industry thinks of water and what planning agencies think of water, I'd like to call on Paul Reed. He's with the U. S. Study Commission in Texas. Their job, of course, has been one of planning for water use for the future. We have in the Study Commission eight basin representatives interested in future planning of their area, the State itself represented, and six federal agencies, comprising a Commission of 16 members. But I wonder, Paul, if you would mind mentioning what some of their thinking is on the importance of water and what the staff has done and their thinking on this - the volumes of water they're going to need for industrial development and how they look at its importance in relation to the industrial and municipal development in this State and the amount that they feel that it is going to influence industrial development.

REED: If there's any one outstanding feature about the determination of water requirements for the area, I think local optimism is probably the most difficult to overcome. You get such situations when you begin to approach this very wide problem as tromping on local toes, and the screams sometimes are pretty loud. I couldn't help but think as we talked here a little while ago about the importance which industry places on water, the number of conferences which were held around the State to try to determine how much water would be needed at various places. Some of the estimates that came in were rather fantastic, and, if the site location that has recently been mentioned is so-called "important," you wonder how a steel mill - recognizing perhaps there's only room for one more in the State of Texas - well, you can find so many of them in local hearings. They keep floating around; you keep catching up with them. I don't know whether there is any actual scientific approach to this thing. We, as technicians, feel that there are - that we can isolate these factors, but I think that many times the local optimism or local ambition sometimes can be misleading. Had you gone back in history some few years, you would have looked at the Houston-Galveston area and said, "Well, we've got water transportation at Galveston; Galveston is the town for growth; there's no question about it; it's got all the features that causes it to grow." And yet, someone promoted a ship channel up to Houston, and now Galveston is a suburb of Houston, practically. Houston was the town that grew. So there are always these hidden factors. How to later figure on this thing is most difficult, and sometimes the political aspect plays the big part.

HAYWOOD: We're finding every now and then in Dallas that we get ourselves trapped in generalities. I don't know whether you have had that experience elsewhere or not. One of the pitfalls is generalizing on the industrial approach to waste disposal. I'd like to cite two opposites. One is the DuPont Company. The executive committee several years ago issued this announcement that they would not approve expenditure for any new plant or any new process if they were not assured that a reasonable means of waste disposal could be provided. This doesn't mean that when a new plant was built that the waste treatment facilities were automatically built - that's not so. I know of some plants where the provision of waste disposal or waste treatment facilities were held in abeyance until their need was more clearly established. Another company, and I won't name it, had this philosophy: "We're not going to do anything until we're made to do it." In between there lies industry, I am sure. I feel that more and more industry will use this general term to swing toward the DuPont approach. But there's a woeful segment which is still adhering to the latter approach. I bring this point out because I think that we are one of the major groups which can and must influence industry's thinking. Only as we become active and vocal at every opportunity can we persuade industry, the latter segment, to swing over to the positive approach. I feel very strongly that that's one of the tasks that faces us as we enter more and more into this water resources management development field. I've forgotten who it was, but somebody stepped on a corn of mine, commenting on low-flow augmentation. This water isn't lost. We're not losing it when we use low-flow augmentation. It's not lost to the economy of the country. Actually, we're protecting, we're augmenting, we're building up usable water which would not otherwise be available if we didn't have this low-flow augmentation. We run into this, and Paul will back me up on this, I'm sure. We run into it in our Title III studies. When we talk about low-flow augmentation, they throw up their hands. They don't want to see water wasted like that. Well, I can tell you it's not wasted. It's exactly the opposite.

I'd like to comment on one of Leonard's points. Maximum development - we've been snowed with that. Everybody wants the reservoir built to its maximum. I'd like to give you this thought. If you build a reservoir to its maximum physical development, or maximum feasible capacity, and there is not - in the demand area - any possibility of growth to the point that this water will be needed, are you doing that area a service or disservice? Let me cite a specific example. We were asked to make a Title III study and the district office of the Corps sent us supporting data - they sent us the results of one of their studies and the results of a study of a water committee of the local chamber of commerce. The Corps estimated that they would need 4 million gallons out of this proposed reservoir, and they said they'd play it safe so they upped it to 6. The local chamber of commerce said that they were going to need 300 million gallons a day. Now I could say that our studies indicated that the Corps was right. Actually, our studies did not. Our studies indicated that the chamber of commerce was more nearly right. But, suppose the chamber of commerce had been wrong and the Corps had been right, and the Corps had sold the chamber of commerce or had sold that group the storage to provide 300 million gallons a day, and there had been no way there for the chamber of commerce to come up with the money to pay for this water. Who's going to lose there? We don't know. I have a strong personal feeling, but maybe I'm not right. Those are some of the things that we're facing in our Title III studies.

And one more point, if we should adopt here and convince the Corps that maximum development is what is needed, we don't need to make any more studies. We're out of business.

SCHREEDER: Does anyone else care to comment?

SVORE: I'll make one comment on this maximum development that Bob didn't mention. At least this area of the country and on west, if you develop a reservoir to its maximum, you can destroy its water quality. You can increase its yield to a point where it does you damage, because your evaporation will be so great that the water you have left has been deteriorated to the point that it can't be used.

SCHREEDER: Do you have a specific example?

SVORE: No, because I know of no reservoir that's gone to this point, but, if you're going to develop a reservoir to its maximum, you should realize what you're talking about. If you're talking about its maximum yield, this could be bad.

SCHREEDER: You're supposed to know what you're talking about before you start talking, I think. Leonard?

DWORSKY: I think the word maximum was not maximum physical; it was maximum feasible yield in terms of the area, the uses, and all the factors that are concerned. I would simply suggest that in our area the Corps of Engineers now, in some of the new innovations in water, is concluding all of its planning on a maximum development basis. We are merely contributing to that. They are not asking us whether they should - they are. And I also suggest that the Bureau of Reclamation and the Corps of Engineers is developing its upper state river basin, some 600 miles of the Jackson Lake in Oregon, on a maximum development basis, utilizing every bit of water. We are contributing to that, and I disagree with Bob that this would put us out of business. I think it would be just as important for our portion of it and merely state that these people are looking toward maximum development. Of course this would vary in parts of the country. Some places, it's essential; some places, it's not needed. And I didn't say, I didn't suggest, that we ought to everywhere do maximum development. I said this is a factor that we ought to be considering as a social gain, a social gain as against merely the allowance of water that you might determine for industrial requirements, because this is a very difficult thing to determine.

SCHEIDT: Commenting on Leonard's remarks - I wonder, Leonard, if you don't really mean optimum development? We're doing some exploring right now in our shop back home with this whole problem in connection with the concept of comprehensive programming which you've all heard about. What we're concerned about is the possibility of utilizing the techniques or programming techniques of other things to get at the problem of what is the optimum ultimate long-range development of a river. There is no such thing as the thinking of just one type of development. There are series of reservoirs; there are series of uses; there are series of opportunities; there are series of demands; there are series of cost aspects involved. And I don't think anybody right offhand has a categorical answer as to what is the best or the most or the maximum desirable development of a river. This is the kind of thing we're going to have to develop a lot of technique, but what we're getting at is optimum rather than maximum development. An optimum would include, Jerry, what you're getting at, I'm sure.

This gives me an opportunity to get into one other little thought that I had in mind at the end of the last session. What Leonard said a little bit ago provides an opportunity to bring it up. We're talking about projection to water use all afternoon. The earlier paper that had to do with the problem of projection to the point of view of population, water demand, industry and other things; the second paper discussed the problem from the point of view of the location factors of industry. But I'd like to just leave this thought:

that we assiduously avoid any effort at preciseness of mathematical certainty. We're talking about planning. We're planning for 50 years or more - long periods of time - and nobody knows precisely what we're going to wind up with. We are engaged in the process of prophesying, if you will. I don't like to use that term but, in a sense, that's what we're trying to do. We're trying to second-guess where we're going to go. And I would urge that, under those circumstances, it is desirable to be a little bit liberal in our approach. It is far better to err on the side of more rather than less. If we put a little bit more storage in a reservoir and you don't need it, it merely means you extend the time period over which the reservoir will be used, because you eventually catch up, but if you put less in, you're presently in a lot of trouble. I just want to leave that thought - that we don't get too much imbued in the mathematics and precise techniques of estimation and forget the intangible factors and the human aspects of what we're trying to plan for.

DAVIS: There's a matter of optimum versus maximum, and, actually, who's going to make the decision? Our national planner is a very conservative man - is conservative in the sense that he sees the limited budget - national planners can only spend so much money, so we'll make that assumption first of all. But he points out the picture of this national planner making the decision of spending money for public health versus public growth. And he poses the contrast of unhealthy people driving along super highways and healthy people bouncing over inadequate highways. I think you can carry it over, if we wanted to, closer to home. That would either contrast education versus water resources development, and, if we spend all our money on water resources and have this maximum development, then we have uneducated people running around - and the educated people going thirsty. Where is the money coming from before this?

REED: If I have drawn any conclusions in the last few years, it has been that the Public Health Service and sanitary engineering in general has been far too afraid to use what it knows. It uses what it knows to be the flaws to scare itself and to be afraid to project or predict into some areas of uncertainty. Other people have not had the same fears, and I think that we're going to have to come to the conclusion that we're going to use the best thing possible. We're going to try to perfect it but, nevertheless, we will not wait until it's perfect to use it. I say this because I have been one that has raised some question marks. I don't raise those question marks because I feel that the speaker should not proceed with what he is doing. I think he should, because it probably represents the best thinking available today. But the questions are wholly an effort - I'm sure the other people who have raised questions feel the same way - only an effort to help to get a little closer to this goal or perfection. Let's not come to the conclusion that we just can't do it because there are some flaws in it.

KRAUSE: I think we've been examining a problem here from one end only. I wouldn't say totally so, but perhaps we've given a great deal of emphasis on the fact that we're trying to forecast something here when, while we're doing this and as a result of our actions - the result of our reports - we're actually shaping the Nation's development in a rather major sense of the word. When you build reservoirs and you say you put in tremendous water supplies for this and other purposes, and the day comes when water is the critical item, then you very well have provided the foundation for developing one area of the country versus development of the other. In other words, you've provided the environment in which that industry thrives. I think this heavy responsibility is something that we want to consider at the very same time that we're considering from the projection end of it as to what this water can be used for. I think as you look at it from the topside, it could very well be that what you're doing here may set the stage for many areas down the road in the future where this will actually result in the development of brand new communities, brand new industries located at the points where water is available. The growth of the country - you say there's 383 million people going to reside here in the year 2010? Where are they going to reside? We know that they're going to go where there are certain things to attract them - recreational opportunities, climate - they move around. I feel that we've got not only to look at it from the side of finding a use for the water that we're talking about, but we've also got to look at it from the other side, to show that if we have the water there, what we're doing to the total picture of the national development over the long haul. And this, really, to me is the thing which concerns me no little. By our actions, what we do, we very well may be shaping a good segment of industrial population growth and where it's going to occur in this country - perhaps what we're doing right now in this forecasting proposition. So we dare not lose sight of both ends of this scale.

PROJECTING WATER REQUIREMENTS IN THE BOONDOCKS

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Much has been said about projections of growth and water requirements for the heavily populated, highly industrialized portions of our Nation - the SMAs (Standard Metropolitan Areas), while little emphasis has been given to the many small cities, towns, and villages outside of the SMAs. The intervening areas served by these less populous municipalities are, after all, the largest part of the Nation in terms of land area. Furthermore, approximately 38 per cent of our population lives and works outside of the 209 SMAs - out in the boondocks.

What method has been used in projecting population, manufacturing and water demand?

To date, projections for population have been founded upon growth trends established over the years, while industrial change has been predicated upon evaluation of manufacturing employment conditions. Water demands for the metropolitan areas can be and are projected through statistical analyses of population growth trends and employment patterns.

Why not apply this method for population, employment and manufacturing, and water demand projections of non-metropolitan areas?

In contrast to the metropolitan areas' steady growth, many small cities and towns have experienced sharp declines in population, even to going out of existence; while others have just stood still. In the latter case, it seems that every time someone comes to town, someone also leaves. Still, other areas grow and expand after many years of little change in population or industrial complexion. This situation with respect to the outlying areas limits the use of a statistical analysis method, since population trends are not clearly defined. Employment and manufacturing patterns seem to be almost as uninterpretable. Since many of our small towns have just recently gained industries, projections would have to be based upon only a smattering of data. The problem of sketchy municipal water use data is also a factor.

How much municipal water demand can be expected to develop for even the largest of the towns in the boondocks?

The municipal systems serving the major communities in the non-metropolitan areas seldom have an average (yearly) demand above 6 to 8 mgd (based on maximum population of 50,000).

This seems like a drop in the bucket compared to the projected Dallas-Tarrant County 2010 demand of 1502 mgd. Are there other significant factors?

Yes, one industry of the principal water using class can completely overshadow municipal water requirements for the area in which it is located. Further, these municipalities are, more often than not, located some distance from a major watercourse. This can create waste disposal problems, since large industrial water requirements may result in large quantities of industrial wastes without a suitable point of discharge. This aspect of water use is all too frequently overlooked.

If the statistic analysis and ratio of employment growth methods of population projection are not entirely applicable for the outlying area, what approach can be used?

Certainly, the population requires a means of livelihood. The industries which provide employment generally develop, prosper, and grow as a result of many factors. While these factors vary from one type of industry to another, most fall into one of three broad categories - market oriented, labor oriented, or resource oriented. All of these major factors are essential to every industrial operation.

How do these affect development of outlying areas?

Since the outlying areas are by comparison to SMAs sparsely populated markets, most of the strictly market-oriented industries seem to locate in or near the big market centers, the SMAs. The second factor, labor, may or may not favor a particular region. But almost without exception, the metropolitan areas have a great advantage over the boondocks in supplying industries' demand for labor.

The third factor, resources, is the key to most of the projected municipal and industrial water requirements for the outlying areas. An inventory of an area's or region's resources will serve as a guide to future developments. These resources can be divided into two groups - depletive and non-depletive.

Depletive resources play an important role in a region's short-term (or even long-term, depending upon the reserves and operation) development though they may not noticeably affect water requirements. These resources are mined, i. e., are not regenerative, and include petroleum, natural gas, natural-gas liquids, coal, sand and gravel to name only a few.

Non-depletive resources are found throughout our Nation and are renewable. These include soil, forests, climate (temperature, growing season, etc.), and water. Agriculture is the backbone of the outlying areas, providing an economic base for many small towns. As the local agricultural economy goes, so goes theirs.

An inventory of resources and existing utilization, population, and employment can be analyzed and correlated to establish future trends in production, employment, and water requirements.

Which resources can affect employment and population growth, and, more important, will require significant quantities of water for utilization?

It is generally true that when raw materials are perishable or bulky or have a high degree of weight loss in processing, the initial step of the manufacturing process is carried out close to the raw material source. There is no question that this factor is of major importance in projecting industrial development and expansion in outlying areas. There is hardly a major water using industry in the non-metropolitan area that is not directly based on local agriculture, forestry or mineral raw materials. The fact is, existence of and access to an abundance of perishable, bulky, or low-yield raw materials not only have been basic to the growth of manufacturing in the boondocks, but will determine the direction of industrial development and to some degree its rate of growth.

While the extraction and manufacture of goods from raw materials are significant in projecting employment and population trends, they do not necessarily influence water requirements. There are, however, two industrial classifications which are heavy water users and have large segments which are invariably located outside of SMAs - Food and Beverage (20) and Pulp and Paper (26).

Considering the pulp and paper products category, first, (since pulp mills are found in all Public Health Service regions) where does water fit into this manufacturing process?

The largest part of this industry's water demand is associated directly with the production of wood pulp from bolts of cordwood. This substantial water use is further a part of the paper-making process. Once the paper is made, there is little water required for conversion of the paper (or paperboard) to cups, plates, boxes, bags, and the numerous useful items fabricated from paper.

Pulpwood is a resource which is both bulky and has quite a loss in the initial processing stage. Therefore, most pulp mills are located in or near forests. Since water is the conveying medium for paper making, the pulp is more often than not passed right on to a paper mill. (When this is done it is called an integrated pulp and paper mill.)

How can regional production for this industry be projected?

The amount of pulp and paper production which an area will support is a function of yield from the forests in the region. For example, the forests of southern Arkansas with good management can produce about one cord per acre per year without depletion. This production rate is based on pine rather than hardwoods (which are slower growing). The kraft paper industry in the South is built and expanding on this resource. Presently, the yield in this area is but half of this amount since there is little or no management practiced on most of the acreage, in private ownership. However, reserves are being built and, as the market for pulpwood expands, expectations are that increased efficiency will materialize.

An additional factor in projecting pulp and paper production is the portion of the timber which will go into lumber and other wood products. Projection for lumber utilization (and employment) should be tied in with the pulp production projections. Currently, the split is about 50-50 in the forests of Region VII. Since the type of timber and complexion of the forest products industry vary from region to region and even within a region, each project area should be studied and projected on its own merits. Cordwood production can then be converted to product output by determining the wood - product ratio. In southwestern Arkansas, the kraft process predominates with a present ratio of about 1.75 cords per ton of product.

Can these timber and production data be translated into water demand projections?

Water requirements for the pulp and paper industry's development can be projected on a gallons per ton of production basis. The predominant process used to produce pulp (and paper) from the type of pulpwood available in the area can be studied to provide the projected water requirement. Although the paper-making process is constantly being improved, there do not appear to be many ways of water saving beyond those now in use. The majority of the requirements are for conveying and washing the fiber stock. As the number of conveying steps and washings increases, so does the amount of water required. Groundwood pulp requires the least; soda pulp the most.

How do the water quality requirements for pulp and paper production compare to the Public Health Service drinking water standards?

Water quality requirements for pulp and paper production are more restrictive in many respects, particularly chlorides and other corrosive elements, iron, manganese, hardness, turbidity, and color content. Until recently, the mills in this region predominantly used ground water, but production expansion programs have resulted in switches to high quality surface supplies.

At this point, consideration must be given to the effect the waste loading from this industrial activity will have on the basin downstream. Will the wastes resulting from this use of water over-load the receiving stream's waste assimilating capacity even after 90 per cent of the BOD has been removed?

Although the pulp and paper industry requires an extremely high quality of water for production, the wastes produced by its operations are perhaps the most difficult to handle in terms of quantity and pollutional characteristics. An average raw waste has a population equivalent of 300 per ton of production (50# BOD/ton) Although, each mill has a distinctive waste characteristic, a study of the region's paper making processes will provide an insight into projected waste production founded on the previously developed data. Return flows are usually on the order of 90 per cent of raw water requirements.

Much research has been conducted by the industry on these wastes and treatment methods have been developed with appropriate engineering guides. There is one characteristic, however, which at present defies economically feasible removal from kraft wastes - color. The level of concentration for this characteristic of kraft waste varies upward from 250 color units. This color is derived from the extraction of lignins and tannins (in the pulping process) and is chemically similar to swamp drainage. This color rules out most municipal and industrial reuse (except cooling water) at this level, and is aesthetically objectionable. Since biological waste treatment will not reduce color, the receiving stream must provide enough dilution to reduce the color to a reasonable level (say 50 to 75). Thus, the waste disposal aspect of pulp and paper making may be more of a controlling factor than water supply.

As the result of research by the pulp and paper industry several processes for removal of color from kraft mill effluent have been developed and tested in pilot plants. All were found to have serious drawbacks. Presently a color removal process incorporated in the causticizing flow sheet, based upon lime recovery, is being tested on a plant scale. Although reports indicate some bugs in the process, the feeling of those working with process is that a solution to the color removal problem can be found. Everything up to this point has turned on projected water requirements for production. Are there other uses for these data?

These projections can be related to employment and population projections for the region under consideration. Paper mill towns in the boondocks have, to date, tended to be dominated by this one industry. Often related operations take root adjacent to the mill, but these do not exert a significant water demand although providing employment. The employment to population ratio can be established and projections made accordingly.

In this way, timber resources, product demand, production, industrial water requirements, employment, municipal population, municipal water requirements, and waste loadings can be tied together, compared with national and regional factors, and projected as required.

We are all aware that these figures will not make these projections work out in themselves, but they appear to be the controlling factors in development of this industry with its associated employment and effect on population in outlying areas to date.

The other industrial segment which can have a great impact on water requirements in the outlying areas is classified under food and beverages - more particularly food processing and canning.

What role does water play in the canning and food processing industry?

This industry's operation is similar to that of the pulp and paper industry. The majority of the water requirements are for conveying and washing of the raw materials and product - fruits and vegetables. The operation is seasonal, but large quantities are required during this relatively short time.

On what basis can water requirements be projected?

The approach for projecting production, employment, etc., can parallel that of the pulp and paper industry. Projections can be founded on productivity of the soil and type of crop best suited to local conditions. The production and employment pattern for the agricultural industry will be discussed by Bill Eichberger. Projected product demands and production figures can be converted to area output in tons or cases or some other convenient unit of measure. While we do not have much data on water requirements, we do have data on waste quantities. Approximately 95 per cent of the water requirement in this industry is released as waste. Table 1 illustrates typical quantities and characteristics encountered. Local conditions may indicate variation from these amounts. As with pulp and paper, employment can be tied to output and projected accordingly. However, this employment pattern is complicated by the fact that this industry is seasonal and will probably not support as much service - related employment, and population per employee as pulp and paper. Details will vary somewhat with locale, however, projections can be made on this basis.

Is the food processing industry's waste disposal situation also like that of the pulp and paper industry?

Waste disposal for the canning industry poses a different sort of problem than that encountered in pulp and paper industry projections.

TABLE 1. VOLUME AND CHARACTERISTICS OF CANNERY WASTES

(From Rudolf's Industrial Wastes)

Product	Volume Per Case (Gals)	5-Day BOD (ppm)	Suspended Solids (ppm)
Apples, sauce		1,685-3,453	
Apricots	57-80	200-1,020	260
Asparagus	70	100	30
Beans, green or wax	26-44	160-600	60-85
Beans, lima	50-257	189-450	422
Beans, baked	35	925-1,440	225
Beets	27-65	1,580-5,480	740-2,188
Carrots	23	520-3,030	1,830
Corn, cream style	24	623	302
Corn, whole kernel	25-70	1,123-6,025	300-4,000
Cherries, sour	12-40	700-2,100	20-605
Grapefruit	5-56	310-2,000	170-287
Mushrooms	6,600*	76-390	50-242
Peaches	1,300-2,600*	1,350	600
Pears	1,300*	2,250-4,700	1,200-6,700
Peas	14-56	380-4,700	272-400
Potatoes, sweet	3,500*	295	610
Potatoes, white		200-2,900	990-1,180
Pumpkin	20-42	2,850-6,875	785-3,500
Sauerkraut	3	6,300	630
Spinach	160	280-730	90-580
Tomatoes, whole	3-15	570-4,000	190-2,000
Tomatoes, juice or products	38-100	178-3,880	170-1,168

* per ton

In most cases, water use and waste production are seasonal with low stream flows and high waste production coinciding. Waste treatment methods have been worked out. However, due to the concentration and quantity of the wastes produced, careful analysis of the ratio of waste flow to stream flow are in order if stream quality is to be maintained downstream from the demand centers.

Compilation of the data outlined will provide a basis for projecting water requirements in the boondocks. Special situations do exist; however, the general approach outlined here should provide a basis for projecting production, employment, water requirements and waste loads for those industries and areas. The technique explored here for a specific part of our work has been used in various forms with an array of parameters for many years in "Water Requirements Survey" work in the Southwest.

Are there any problems associated with this approach to water requirement projections for the boondocks?

Although this technique will yield a fairly good projection of areal water requirements in the long run, it does not furnish a clue as to when and where this demand will develop. Pulp and paper water demands can go from nothing to 50 mgd with the construction of just one big mill or it could develop in medium sized increments. Local management may be able to furnish the answer; however, they are prone to keep long-range plans to themselves for competitive reasons. A local management interview will not be possible when no mill now exists in the project study area having a projected potential.

In summary, on what basis can water requirements for an outlying area be projected?

There are 4 general steps which can be used to project water requirements for the boondocks -

(1) The area's resource inventory holds the key to its growth and development.

(2) The area's water using resource-oriented industry (or industries) play a vital role in determining future water requirements. Pulp and paper production and food processing are outstanding examples of this type of industry. Water requirements can be projected directly for these industries.

(3) Employment and population patterns can be founded on the resource base for relatively remote communities. Municipal water demands can be projected proportionate to population to be served.

(4) Waste loadings to be released can be predicated on industrial water use and municipal water demand.

What one factor will have more effect on projected water requirements for the boondocks than any other?

Insofar as projections of water requirements for the boondocks are concerned, it would appear that, in Region VII, waste disposal (stream quality maintenance) will be more of a controlling factor than any other. How about your area?

DISCUSSION

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First, may I be allowed to agree with my good friend, Dick Hager, in that projecting water requirements in the "boondocks" is a most difficult assignment. Logically, as Dick has pointed out, the usual items such as population and industrial growth potential should be investigated first. If a water demand, either for consumptive use or for dilution of wastes can be obtained by the use of these factors, the problem is solved. I must agree, however, with Dick, that this is not the usual case insofar as the "boondock" area is concerned and so other factors must be considered.

Dick has once again pursued the logical path in using the area's natural resources in considering what effect these resources would have on the growth pattern. In quite a few instances a combination of natural resources, population, and industrial growth potentials, indicates that there is sufficient justification for the proposed project to warrant its construction when water supply is considered along with other multiple-purpose aspects. I must also agree that up to this point the procedures which have been outlined are proper, but let us go one step further, into a truly "boondock" area.

There are areas in which, even when given every consideration, water supply storage cannot be justified under our present economic criteria. We in Region VI are confronted with just such an area. Let us consider the various factors which we have discussed above as being those factors which should be used in giving economic justification for the storage of water.

1. There are only seven municipalities in this particular basin. The largest community has just over 9,000 persons and the total for the entire seven municipalities is 28,765 persons.
2. Five of these communities have sustained a heavy loss in population since the 1940 census. The other two have shown a gain in population, but this gain is very small. Each community has recently installed the equivalent of secondary sewage treatment and sewers serve more than 90% of the population.
3. All wastes, both municipal and industrial, are treated by the municipal facilities. There are no large industries within the area.
4. Natural resources consist of gravel, sand, stone, coal, and clay. Stone, gravel, and sand operations are found in each county and so are very small concerns. Use of coal which is mined from this area is restricted to local consumption because of low quality. Clay deposits are being mined but, here again, these operations are very small and do not have any prospects of becoming larger.

5. Forest area comprises 10% of the basin, 440,000 acres. Lumber and wood using industries are presently utilizing this resource to the maximum possible. The Missouri State Forester states that, in his estimation, there would be difficulty in maintaining even this amount (440,000 acres) in future years, as the basin historically has cleared timbered areas for additional farming operations.

The above are facts which we must presently use in determining if future water demands should be stored in the series of reservoirs proposed by the Corps of Engineers.

I do not believe that anyone will question the fact that under our present guidelines we could not justify a recommendation that water supply storage be made a part of this project. Should this matter be dropped immediately as being an unfeasible project or should we go further in our analysis of what might be done. Let's just consider one aspect.

Granted some specific time must be used so that the economic aspects can be determined, is the present guideline of amortizing a water impoundment reservoir over a 50-year period a realistic attitude?

What do we really know about the life of a reservoir? Several factors could be considered, and the one which would play the most important part is sedimentation.

A considerable amount has been written on this subject, although it is not believed that information is available to determine the exact sedimentation rate for any given stream. If this is true the exact life of a reservoir cannot be accurately determined. Certainly, it must be recognized that there will be a slightly different life expectancy for each individual reservoir, but most people who have made any statement concerning life expectancy give a clear indication that, in their estimation, the life of a reservoir should be considered as 100 years rather than 50 years.

Another matter which should be recognized is that there are only a given number of reservoir sites within this country. If these reservoir sites are not utilized to their utmost, then as additional water storage is required, more costly construction methods and land costs, assuming that it is possible to store additional water in these sites, would be entailed.

Possibly, I have rambled at length; maybe what I should have said is that as the time approaches when additional water is needed some remedial steps must be taken to capture the water which presently flows uninhibited to the seas. It is certainly expected that at some future date water will probably be transported from a plentiful water area to those areas which will be deficient in water.

Now I want to go back to the original problem. There is a surplus of 2,500,000 acre-feet of water in the basin presently under study. Using our present guidelines, the storage of this water cannot be economically justified. What action should be taken if a decision is reached to construct reservoirs for flood control?

I do not propose to have an answer to this problem because the criteria which is presently used is established by law. The only purpose of bringing this matter to your attention is so that consideration can be given to this item if you feel that the item is of sufficient importance.

GENERAL DISCUSSION

THOMAN: I think Frank has posed a real good question here on the period of analysis. One question that comes up to me is whether or not you might defer a project there until some future time.

DWORSKY: To continue the discussion yesterday, there is another factor that I want to add. In terms of the question of what we're going to do now, in terms of problems that the folks here have, and we all have, in terms of the answers that we now have, it was quite clear that we've got to live within the guidelines established by the law, and this, in itself, is going to force us to come to certain conclusions which we, as folks interested in water resources planning, would feel provide an intervention against the proper development of our resources. Nevertheless, whatever view is ours, the Congress making the laws has added the current guidelines. So I think the problems that we have are going to be met within those guidelines. This will be our real basis. The second point, then, what would we like to do, and this is partly seen in the AWR studies in considering the guidelines on the field. We've got a work group out there now between the Bureau, Corps and ourselves in terms of looking at the guidelines and we want to make recommendations for adjustment of those guidelines. The adjustments of the guidelines of the BOD 500 were not lacking in support from our organization since as early as 1950. In the papers and reports and discussions that the Public Health Service had with Mel and the Bureau of the Budget on this matter, I think he knows and agrees with the fact that we were one of the few groups that tried to stimulate these changes in water supply standards, and I think that we still have this test ahead of us, to look forward to making changes. I think that the studies that will come out of the AWR studies and others should look forward to making recommendations through policy channels for the adjustments that we feel and agree with the folks - we can make determinations on these things and help this matter go forward, but in some of these areas we're going to have to help through the development of new policy in terms of getting these to the proper parties.

SCHEIDT: Let me supplement a little what Leonard said, and up to the point that Frank raised. This question of what is going to happen in the future - the question of how far ahead we can plan - is a pretty serious one, and I detect this concern running all through our discussions here, yesterday and today. We do have to live with the law, but I think there are some trends indicating in the direction in which we want to go which might be useful, which we can seize on, and I want to point them out. A Select Committee on these other recommendations pointed out the desirability of the Federal Government in its program of river basin development actually acquiring or preserving the reservoir sites. This ought to be done. It seems to me if the reservoir sites could be reserved, or if in the process of building a reservoir for a given quantity of water as determined say, by us, at the present time would indicate a definite limitation from the size of the reservoir as of now, there still could be under this new policy being suggested by the Senate Select Committee, the possibility of reserving the total site area, even though you're not going to develop it to its completion at the present time. To illustrate, if you build a reservoir of a given limited capacity now, although that site is capable of three or four times that magnitude of development, what is likely to happen in connection with going forward with the future development is the encroachment by expensive development along the shores of the reservoir. Under the policy of reservation, it might be possible to acquire the lands around the reservoir to the maximum foot level of the future reservoir, even though you didn't build a dam that big at the present time. It's always possible to build a top to the dam. What I'm suggesting then, is that we all begin to think about how, in the process of working with our people in the various regions, we can begin to foster and to stimulate thought and back up this proposal of reservoir sites being acquired in advance, even though it might be many, many years before we actually build them.

WITHEROW: I'd like to bring out a point, or a question, really, to the speaker, which has been discussed among us several times, and the one which seems to be our basic question of the last half hour, and that is the question of time. We have talked about in the pulp and paper industry and in the food industry, and the petrochemical industry, a maximum development of an area based on the resources. Yesterday we talked about the difference between maximum and optimum, and this idea of optimum brings in this idea of time again. The big unknown, when do we reach this maximum development? I wonder if Dick would give us some ideas on the methods he has used in the past.

HAGER: Considering the pulp and paper industry, there's an ample forest area in this country in the various regions that are now supporting paper mills to serve very well through the year 2010, providing that the forestry practice picks up. For example, yields of 1 cord per acre have been projected for Arkansas. The fact of the matter is that today that region is producing less than half a cord per acre on most of the acreage. Management practices would have to improve to meet these future needs.

The same thing is true of agriculture. Yields can be expected to jump in proportion to the demand. As demand builds up, some of these areas that are now not doing very well will be turned back into crops, if they can. As we go on into the future, we can expect that these areas will continue to work on these resources.

For petrochemicals - there is a limit. We're working on 20-year reserves now. We've had a 20-year reserve for the last 20 years. There's always been 20-year reserves.

We are now using more gas than is going into the reserves. We have a situation here where there's either going to have to be more exploration and more discovery in this country, or eventually our gas reserves will be drawn down. That would be a controlling factor in the petrochemical industry.

As far as food and pulp and paper is concerned, it seems from the people that are first in the field that maximum production is still far beyond our study limits.

OWNBEY: I'd like to comment on Frank's question about his 50-year plan versus physical life. I think it is nice that these projects will have some useful life even after they are paid for. On the other hand, there is some reasonable length of time, some period, in which the benefits of the project returns should be sufficient to fully amortize the investment. It is well that we plan for the future, that we plan for it for the needs of future generations, but we shouldn't present our grandchildren with a life that is completely planned and also fully mortgaged, so that they have a few decisions of their own to make. They have to devote most of their energy to meeting the payments of this amortization schedule that we've set up for them if we use too long an economic life.

ROGERS: Dick, I have another question that came up there when you were talking about these reserves in Louisiana. In those studies are you looking at the competitive status of some of these areas compared to other areas outside? That is, is the pulp and paper industry more likely to develop in Louisiana than in some of the study areas you studied?

HAGER: I was afraid you were going to ask that. Here's the bug in this thing mentioned in the paper. This is the problem in the boondocks. We had an illustrated example of this in M. L.'s petrochemical study. He said he looked at Garden City, asked a little bit about Garden City, and it looked like it would be a good spot for a fertilizer plant - petrochemical inorganic fertilizer, nitrates, and so forth. So when I was on a trip to Kansas I talked with the Industrial Development Commission, and asked, "What do you think about Garden City as a spot for a petrochemical plant?" They said, "Standard Oil has bought up a great deal of acreage there. They're trying to get it off the ground, but there are some problems, and they pulled out."
"Do they still own the ground?"
"Oh, yes, they still own the ground, but they're not going to build the plant for awhile yet. They're having difficulties."

This is the sort of thing that can really mess up our demand curve. If the production is coming along fine and dandy, but the board of directors decides that southern Georgia would be better for their next expansion, or maybe down in the Houston area, in Pasadena, then, this demand curve isn't worth a darn, because you have no way of taking this human element into account. It would be foolish, to draw that curve, because it isn't going to develop like that. Who knows what shape that curve is going to take?

HAJINIAN: I think what Mr. Rogers - something that has been bothering me, have you considered any competitive advantages? Why is your area better than the Georgia area for this growth? I feel you have done this, and maybe this is what you are asking, Mr. Rogers. What makes your Arkansas area better, let's say, than the Georgia area for this sort of growth?

HAGER: It doesn't make it any better.

HAJINIAN: Well, then, I think his point is, if it doesn't make it any better, why do you put it there?

HAGER: Because the national demand for paper is going to be so much. It's going to come from somewhere. The share of the market that this area can capture is based upon how much raw material there is available. Now, if Georgia should suddenly, through wonderful forestry practices, be able to produce at a much greater rate much cheaper than they can in Arkansas, then it would appear that they would get the nod, and these areas would not. But as things now stand, based upon current knowledge and forestry practices, this is the amount of market that they can be expected to capture. This is their competitive position.

THOMAN: I think what Herb was hitting at - and this has disturbed me a little bit - up in the Study Commission someplace we decide that this area looks good for a paper mill - Dick does the same thing over there, and Frank does it up in Kansas City - each of us is predicting a paper mill. It would seem to me that it would be possible for predicting or forecasting or something, more paper mills by the Public Health Service than the national market would sustain. This gets to a point of coordination of efforts, and how to carry that out, I don't know, but with that one thought - Jim, would you like to say something?

FLANNERY: I didn't intend to be drawn into this, but I'm never able to resist. I think, to go back to an earlier point to lead into this one, the time period of analysis - I doubt that that is written into actual legislation. I don't believe any of them say that, even the Title III ones, but I won't bet any money on that. The period of analysis comes from an interagency agreement, usually an agreement made - the Bureau of Reclamation, I believe, uses 100 year repayment periods on some projects, and even a few have a longer period than that. The 50-year period of analysis is chosen, probably less on amortization features than just the function of uncertainty - obvious uncertainty is compounded, greatly increased, as the time period grows. I would be very dubious as to what these projections will be at 25 years. If you want to extend it beyond 50, particularly in the boondocks, this is, as I say, flatly impossible. All I say here is, as the question Herb Rogers put very well - why, in Arkansas, and not Louisiana? Why on one side of the river and not the other? It just means in some cases going from one State to another - not change the national picture, but Arkansas is gaining, Louisiana has lost, for instance. And the obvious political displeasures of this may result. I keep wanting some national projections - and then some - it would not be simple - then some regional allocation. We've got a national projection for pulp and paper production in the United States, some appraisal of the forest research. We are at the whim of a board of directors, and there's much subjectivity involved here. We don't know that they'll go into Pine Bluff, Arkansas - or what's this Canadian outfit over at Texarkana? Bob Haywood and I talked to the people in Texarkana. They were suggesting that a foreign company was coming in - wouldn't say exactly what it was. We got some pretty good dimensions of it. Actually, their water use currently is somewhat less than we had anticipated. But they could have gone anywhere up and down the Red River, or left the Red River area entirely, and gone into Louisiana, producing the same volume. We don't know how far the transportation area would bring the raw material in. What we have to strive for is a reasonable standard, but I would want to base it on a national total, with some regional allocation. Then when you get down to the problem of saying which particular river basin, what river mile - this frightens me, I dislike that. I think within a hundred miles. We've had instances in east Texas where you say, well, if the reservoir were built close to this community, everyone is happy in that community. But if it were built six miles away - so it would be again an effect on the other communities, then public support diminishes in the first community. The point we have is that in east Texas there must have been 8 or 10 reservoir studies done over an 18 month period in which it was somewhat embarrassing to me, because you look back and find the same several communities' water demand included in three or four of the reservoirs. Now you could drop one out as a particular reservoir is built, but we do have a great nature for putting the paper mill everywhere. There are trees and the paper mill can fit a lot of places. I'll bet we do have a saturation of paper mills. And the question of why, or when, is very pertinent. Resources for the Future has done some studies - I think if we avail ourselves to some advantage by taking a national projection, I think that we can look through some of these projections done by the study group, not because of their special soundness, but because they do give us a dimension. The best story I know in this regard is, the 12 Federal Reserve Banks of the United States - their economists, of varying degrees of capability and what-not, each have done a projection of the population growth in their district. And Bob Harrison of the Study Commission showed that the forecast of each of the Reserve Districts shows that they will grow at a rate greater than the national rate. Well, this is magnificent - this is built-in optimism. I would be willing to throw my efforts into this thing regionally and try to find these projections. I mean, what will happen? What will be a reasonable disposition of the growth magnitude?

HAGER: These projections I'm speaking of were based upon quadrupling of the demand for pulp and paper in the country. There is not now being produced enough pulpwood on what exists in timberland to meet this 50-year projection that the forest people make, so I don't think we need to worry about that. The other factor that comes in here is that there are other demands for forest products besides the pulp and paper industry. About 50% of it goes into boxes and chair arms, and so forth and so on, but I agree that this regional thing is tremendously important and getting together with the people from the other pulp and paper producing regions is extremely important.

FLANNERY: How about the international picture - Canadian -

THOMAN: Let's don't complicate it.

WEISER: I think that we all agree here that this a national economy and that the industries with which we are concerned are industries that make their decisions on a national basis, the ones that are most concerning us, so then, some kind of analysis on a national basis, perhaps, is indicated. We have said that certain managers, or certain boards, are making decisions, and we have also said that we don't know what those decisions are going to be, and this hampers us in our projection. I think that at any point in time there is a most likely development in the over-all paper industry, that the sum of the projections within each one of these corporations or the over-all paper industry can be evaluated. I also think that there is a national possibility for these locations - for the locations of these developments, and I also think that you can determine at a particular point in time the feeling of the various boards if you inquire as to how close a competition there is between the various areas. I think that a board could tell you that it is considering equally at this point in time over the next 20 years to establish a certain number of mills in these two areas, let us say. Now take northern Georgia and your Arkansas or Oklahoma area. This company tells you it has these two places in mind - another says it has a northwestern and an Arkansas area in mind for certain development over a certain period. I think you can take these if you inquire and go to them. I think you can take these and get a national picture.

KEHR: I've been listening with much interest to this. One thing has seemed to me you might consider in attempting to determine where these mills would be, and that would be this: Over a given period of time, the national projection would indicate that a certain number of mills, or a certain capacity must be available. One would presume that this would be done annually on the basis providing so many tons of capacity. It would seem to me that this would lend itself to some kind of statistical analysis under which you could say that by a given time the probabilities of building a mill in a given area were thus and so. In other words, you have indicated a point there. You didn't know when that point would be reached in the line that you indicated. It may not be reached until the last, but somewhere between those two points there must be a probable situation where this mill might be statistically predicted to have been built. And I see no reason why this could not be used - this time could not be used, giving the probability that, let's say, 70% probability that it would be built, say, by 1981.

HAGER: That sounds like a good idea.

SMOUSE: It occurs to me that someone has an obligation to consider the national picture with respect to where paper mills and things of this type should be located. What I'm trying to say is this: A mill located on a certain stream may destroy the use of this or these waters for a large area, whereas if that same size mill were located in another location, the ultimate effect would be much less from the standpoint of destroying the national resource. My question is, do we have an obligation in this regard, or if not, who is watching this aspect of these developments?

HAGER: With local regard, all of these paper mills in Arkansas and Louisiana are located on one watershed. It's just a question now as to where they land in the watershed. And this is the question: Will the mill go where the best spot would be in terms of water supply and waste production? Or, would they go on their whim of going in and overloading the stream? Now, the question I ask myself on this thing was, if the mills double capacity (as they indicated they'd like to do very soon) what's going to happen to this stream during low flow? Mathematically it looks like they're going to be back where they were several years ago. We're approaching more and more this need for overall plans and coordination with industry. At the moment, the state agencies are the ones that tell us which way to go on this. We talk to Arkansas, we talk to Louisiana, we ask them what they think about these things, and they give us their very candid opinions. They're not backward at all. So that's the criteria we use on the waste end of it. What they say they would want to do.

VANDERHOOF: I would like to address my comments to Mr. Jacocks. The question of what to do about water in the boondocks - 27,000 people and you know that they want a water project in the area and you know pretty well they're going to get one. Now, do we go on and include in that project some water demand? I notice one of the reasons that you used, Frank, was that there were a limited number of sites. I believe this statement applies to a few truly magnificent multipurpose sites, and very probably there are thousands of ordinary sites. It might be just as well to let these people have their flood control project and then if you can't really see anything about projecting, you're not condemning them to a fate of no water forever, you're only holding back, let's say, another ten years and take another look. So I wouldn't be too concerned right now about taking land out of reservoir areas and zoning them, in effect, to be forever used as a reservoir area. I think very probably in most cases you can go 30-40 miles away and come up with one almost as good, and in the meantime you won't have taken out thousands of acres of private land on which the community cannot get taxes.

GLOYNA: I don't agree with this statement of planning for reservoir sites. This is not true - at least it is not true in very many sections of the country where the water is rather badly needed and where the water is rather bad in some places. I feel this because having worked on some of these river basin studies where we try to use some of the sites that were available, the best available, and yet not good enough to get say, maximum development of the basin. We just have too much adulteration. We have water that is too bad to begin with - that is from natural problems - and generally speaking, unless we bring it in, I don't think that your statement is quite right.

JACOCKS: Just one thing, Dick said that we were not condemning this area forever. I agree with him on that statement, except for one aspect. Remember that we have to use an enormous amount of facets in order to justify any individual site. So if your flood control reservoir is put in, then if there's any future reservoir to go into that area, ycu cannot have as a part of the justification flood control, because that's already been put into another reservoir. So from that aspect you may be condemning - I don't say you are, I say you may be.

HAGER: One rebuttal - I think this only points out that each region must be considered. I have particular reference to the Ohio area. Apparently Mr. Gloyna has reference to a drier area.

NOBE: I'm beginning to wonder whether we're not overlooking another dimension of this thing. As Dick was pointing out, looking at paper mills and comparing one area with another, I would like to interject that we have to look at competition among other industries as well. In some areas for something to come in that's a heavy water using industry - some other type of industry has to go. It may be agriculture, and if you get a bunch of experts looking at one type of industry, another bunch of experts looking at this industry, and they never get together, you'll have worse problems than this inter-regional.

INTRODUCTORY STATEMENT

By Dr. Willis G. Eichberger, Economist,
Water Supply and Pollution Control,
Public Health Service, Region IV

Before I start my paper, I would like to comment on this matter of industrial location that we got into. It seems to me that we were discussing something that certainly had serious economic implications. Herb Rogers brought out a point that I want to follow up, because it is a point that requires serious reflection. I don't think that when we go into these areas, these small areas, and we're working on municipal and industrial water requirements, and we're talking about industrial water requirements, I don't think that we can say, "Well, here is an area that is going to produce a lot of vegetables. Therefore, we'll put a food processing plant here." Or, "Here is a vast forest area, therefore we're going to put a mill here." I don't think it's this simple. And I think that we can get ourselves into a trap or into a box by not adequately analyzing the situation that we're facing. The pulp and paper industry today, or as of the 15th of last month, at least, was producing up to about 90% of capacity. We have unused capacity in our present mills. This is one thing we have to think about when we think about the future. I think another thing we've got to consider here is the national picture. No area works in a vacuum in our national economy, and I think we have to consider the national picture, and the regional picture. Where do we go to get information? What guides can we get hold of here to help us? Well, we can go to the Department of Commerce - they have something like 23 industrial specialists - each one of these a specialist in a single industry. Through their survey of business, they get a pretty good idea as to the attempt of expansion and new business. In other words, they get industry's intent. You've got to make use of that one. Right in the center of Arkansas - in Pine Bluff - International Paper put in a multi-million dollar plant. There was a reason why that was selected. There's always a reason why industry selects a given location. The plants in Georgia and throughout the Southeast are not necessarily located directly in the center of the resource. If you'll look at that map that Dick had and his paper, you'll find that they're not necessarily located in the center of the resources. There's a lot of them down in Savannah. Materials move. And I think that when we think of putting in an industrial plant of any kind, that we have to take into consideration - first of all, we've got to know something about the total national demand - future demand. We have to get some idea regionally, where plants will be located. Then when you get into a region, remember we're working on M&I, and what we want to know is how much water is going to be used out of this particular reservoir. This means we've almost got to pinpoint. We've got to do this for a lot of our industries, and this becomes a very, very difficult thing.

Over in the Southeast, in Alabama and through Georgia, running southwest, to northeast, it seems that they have discovered a vein of iron ore across there that has the indications that this might support a steel mill on the Chattahoochee River. This is not definite, there's too much still unknown, but we're working on the Chattahoochee. This thing is causing me headaches. If in the future I predict a steel mill to go in on the Chattahoochee and if that steel mill never develops, this puts Public Health in a pretty bad spot. On the other hand, if I miss it and say, "Well, there's no possibility of a steel mill here," and ten or fifteen years later a steel mill does in fact go in there, we're just in the same boat. But we have to be pretty careful. We've got to run down every source of information that we can possibly run down.

by Dr. Willis G. Eichberger, Economist,
Water Supply and Pollution Control,
Public Health Service, Region IV

AGRICULTURE - EFFECTS ON WATER DEMANDS

INTRODUCTION

As long as water is in abundant supply to meet the demands of all water uses or purposes, demand for water presents no problem. It is only when supply is small relative to demand, so that competitive alternatives exist, that concern over use of water occurs. In many, and probably most, parts of the United States today water supplies to meet demands of all legitimate water uses are limited either quantitatively or qualitatively. Because of these limitations on water supplies and because of increasing demands for goods and services produced by water resources, we must consider the possibility of obtaining the greatest possible benefit from our water resource supplies.

In any given area water use is rarely, if ever, confined to a single purpose. It is used for human consumption and other necessities of human livelihood, animal consumption, industrial production, fish and wildlife habitat, and many other uses too numerous to mention here. Any or all of these uses present no problem as long as the quantity and quality of water required for each purpose is sufficient to meet the demand. It is only when quantitative or qualitative restraints are placed on the supply that choices must be made between alternative uses. When limitations become operative it becomes necessary to establish criteria to specify efficient use of the diminishing supply. These criteria should serve as the basic framework, consistent with needs, laws, and policies, for modifying physical means of water use. In the field of water resource investigations inquiry should be focused initially on water supply, total demand for water supply, total demand for water, value of water for particular uses from the public point of view, and costs (private and public) of particular uses. Finally, efficient allocation of scarce water supplies between competing uses should be based on the principle of maximization of economic welfare. Before we can deal intelligently with the problem of efficient allocation of our water supplies among the various competing uses of water, it is necessary to make educated guesses as to the future demand of each alternative use.

Agriculture is the largest single water user of any industry in the United States. In 1955, eleven western states supported about 25.5 million people. These states withdrew about 104 billion gallons of water per day from surface and underground supplies. In the same year, the eleven most populous eastern states supported about 78.5 million people. These states withdrew about 68.5 billion gallons of water per day. Thus the eleven western states used 4,112 gallons per capita per day as compared to 872 gallons per capita per day for the eastern states. This difference in per capita use is attributable almost entirely to irrigation requirements.1/

PROJECTING FUTURE REQUIREMENTS

Because our water resources investigations must necessarily be concerned with the future, it is necessary to make estimates or projections of future demands for water for agricultural uses. These demands will be determined by farm population, numbers and kinds of livestock on farms, and the acreage and kinds of crops expected to be grown. In the arid west and in those parts of the humid east where rainfall is improperly distributed seasonally for optimum crop production, irrigation will be a big factor in water use.

In order to project future demand for water for agricultural uses, it is necessary to study the agriculture of the area under consideration to (1) get a good picture of the agricultural industry; (2) analyze the changing trends in agriculture; (3) assist in the determination of agricultural population and employment; and (4) determine the type and volume of agricultural production and the potential for agricultural production. Before attempting to analyze the changing trends in agricultural production, and before their significance can be fully comprehended, it is important to understand the forces to which they respond. Perhaps the most important and certainly the most obvious change in the agricultural economy has been caused by the impact of technological innovations. The widespread adoption of mechanization and improved farming methods has displaced a considerable number of agricultural workers. Some of this displaced labor has been assimilated by other industries and some has become surplus to the area. Furthermore, mechanization has materially increased agricultural production, both in terms of output per man hour and in terms of total output. Even though the acreage of cropland has remained stable or, as in some areas, has declined, agricultural production efficiency has increased. This increased efficiency is largely attributable to mechanization, although increased use of commercial fertilizers, improved farming methods, soil conservation practices, and other innovations have also been contributing factors.

Mechanization, however, has not been equally rewarding in all lines of agricultural production. Increases in physical productivity of labor engaged in livestock production have not kept pace with increases in output from labor engaged in crop production even though

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[1] Irving K. Fox. Water - Supply, Demand, and the Law. Resources for the Future, Inc. Washington, 1960.

improved breeding and the development of more efficient feeds and feeding have been widely adopted in the livestock enterprises. This is because the gains made from improved breeding and feeding have not resulted in the saving in manhours that have been realized in crop production from mechanization, even though livestock production per manhours expended has increased.

Rather than reducing manhours worked per capita, increased agricultural productivity has resulted in a reduction in the number of farms and farm population. Trends in increased productivity indicate a further reduction in farm population. There is a limit to labor displacement by mechanization, however, that many authorities believe is already near. In general it can be expected that future technical efficiency will result mainly in efficiency through increased production rather than in efficiency gained by further reduction of labor. Increased efficiencies can be expected from technical improvement and mechanization in newer methods of vertical intergration in livestock production.

Analysis and understanding of the forces that condition trends in agricultural production assist in making explicit assumptions regarding future agricultural output. These assumptions may be stated as follows:

1. The downward trend in employment caused by increasing mechanization will continue, but farm population should level off and may even increase in response to increased demands for foodstuffs.
2. Improved soil conservation practices, already implemented in so many areas, will be even more widespread.
3. The trend toward diversification of crops will continue.
4. Better plant and animal breeding will help to increase farm production and income under normal conditions.
5. Higher yields per acre through use of commercial fertilizers and irrigation and higher yields per man because of mechanization are trends which will continue.

These assumptions are prerequisite to projections of farm population, farm employment, and potential of agricultural production. They do not, however, lead to a formulation of projected needs for agricultural production. Additional assumptions are necessary relative to the needs for certain types of production that help to explain trends in changes in agriculture. Based on what we know about population growth, industrial development, personal incomes, and rising standards of living, we can set forth the following postulates:

1. Considerable increase in whole milk production can be expected in response to the increase in size of nearby urban areas. Considerable increase in vegetable production can be expected also with higher personal incomes and higher living standards.

2. Continued emphasis on livestock production for meat, particularly in those areas where potential increases in capacity of the land are great, can be expected.
3. Agriculture will continue as a major support of the economy in many areas, but it is not likely to continue to account for as large a percentage of total income as it has in the past.

All of the factors considered in the agricultural economics analysis must lead primarily to two considerations: (1) the forecasting of the potential and the probable extent of agricultural production in the future; and (2) the number of people employed in agriculture. The latter is important to the consideration of municipal and industrial water supply because a segment of the population of each area will be engaged in serving agriculture. In addition, water required for agricultural uses may have tremendous impact on water supply available for other uses and on total water demand. Before it is possible to determine the impact of water requirements for agriculture on total water demand we must get some idea of the agricultural requirements for water. This will involve making projections of total farm population and numbers and kinds of livestock to determine domestic water requirements, and of the amount of water required for irrigation. Total domestic water requirements can be estimated by applying per capita use rates to population and livestock. Per capita use per person for personal and household uses can be expected to be in the neighborhood of 100 gallons per day by the year 2000. An estimate of livestock requirements can be obtained by application of the following factors: for one milk cow (for drinking and washing utensils) 35 gallons per day; for one beef cow or horse, 12 gallons per day ; for one hog, 4 gallons; for one sheep, 2 gallons; and for 100 chickens, 7 gallons.[2]

Data on the amount of irrigation water needed for each acre of land are available from several sources. The best data on water requirements are those obtained from successful farmers who have reliable water supplies in the general area under study. Experiment station records on irrigation use, when adapted to actual farming practices, are also helpful in estimating farm delivery requirements. Considerable data on irrigation requirements are available from the Bureau of Reclamation, Department of Agriculture, and State agricultural colleges.[3] The data available will lead to a determination of present total water requirements for irrigation which includes not only farm consumptive use but also farm losses and irrigation system delivery losses. What we are concerned with, however, is total irrigation requirements in the future. Here again, technology must be taken into consideration. Crop adaptation and improvement, pest control, adequate fertilization, and erosion control have removed many previous barriers to sustained high yields, particularly in the eastern United States. Engineers and other scientists are continually working on techniques of reducing irrigation system losses and farm irrigation water losses. Assumptions regarding the extent to which these irrigation losses may be reduced in the future are necessary to a projection of future irrigation requirements.

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[2] Planning an Automatic Water System. The Penn. State University, Coll. of Agr. Agr. Exp. Sta. Cir. 382, May, 1951. University Park, Penn.

[3] Water Facts for the Nation's Future. Langbein and Hoyt. Chap. 10 Ronald Press. New York, 1959.

IMPACTS ON QUALITY AND QUANTITY

The expanded use of pesticides may increase crop yields but the increase in yields may be at the expense of impaired quality of water for other uses. Existing evidence indicates that in areas where pesticides are used in large quantities, runoff from these areas contains enough of the undesirable soluble material that water quality is impaired. Available evidence indicates that the natural organic and synthetic organic chemicals dissolved in the runoff from pesticide-treated areas are not removed by presently known water treatment methods. Not enough is yet known about this problem to determine whether it will have pathological effects on health. However, it is a problem with which we must be concerned when considering the development of surface supplies of water for domestic and municipal uses in those areas where large amounts of pesticides are necessary for profitable agricultural production.

After determination of the amount and distribution of precipitation in the area, the effect of total water requirements for irrigation and farm domestic use on available water supply and on total water demands can be determined. This assumes of course that total water requirements and demands for other uses have already been determined. However, knowing the requirements for each use and the impact of the demands of each purpose on total available supply does not answer the question of which purposes would be served or which uses should have priority.

ECONOMICS OF ALTERNATIVE USES

It appears to me that in any water resource investigation, the question of priority of use among competing alternative uses is the crucial issue. Some ordering of priority in use may be quite easy. For example, water use for human consumption undoubtedly has the highest priority. Similarly, control of water to spare human lives in flood has high priority. Beyond these points, however, ordering of use is not so "clear cut." and must involve much more study. To sustain life both food and water are necessary. Abundance of both probably will not be possible in years to come. In addition to food and water, we also need those manufactured goods and those services provided by our natural resources that will enable us to maintain the standard of living to which our people have become accustomed and which have become necessary parts of our lives. This does not mean that the highest tail fins on automobiles are necessary, or the most gadgets, or two cars in every garage, or a country home in the mountains or on the water front, but rather those things that we have come to feel as necessary to civilized living. How can we best control our resources so that we will be assured of plenty of water for necessary livelihood, plenty of food, and plenty of essential manufactured goods and still have enough for such necessary things as recreation and outdoor living and enjoyment? Many solutions to this problem are possible. For example, we might: (1) Set priorities on food production and allocate the amount of resources required to meet the food goals. (2) Zone the country by regions so that each region would produce only those things to which it is particularly adapted. This would mean producing food only in those areas particularly adapted to food production of given types with the least input of natural resources. (3) Divert more of our human and financial resources to research in the field of new synthetic foods. (4) Let the pricing mechanism, and where inapplicable, legal and social means, be the guiding criterion for resource allocation. Because the latter appears to be the most practicable and the most palatable from the standpoint of a democratic way of life, I should like to pursue this possibility a little later.

If we are to attain the goal of maximization of economic welfare we must allocate water resources to alternative uses in such a manner that the goal will be realized. The objective to be attained is to help maximize economic welfare of society in total. This requires getting the proper balance between uses and weighing the gains from each use against the cost. This brings me back to the beginning of this paper - the efficient allocation of water resources between competing uses which I consider is the first major condition in meeting the goal of maximization of economic welfare.

Three steps are necessary to attain this condition of efficient allocation. First the determination of the supply of water. This includes the total quantity available to the geographic sector under consideration. It includes also the distribution of the water supply among localities and seasons of the year and its storage possibilities to alter the supply between different time periods. Second, the determination of alternative uses and the production possibilities of each use of the given water supply. The nature of these two steps is largely physical although important economic concepts are involved. Although these two steps can be accomplished expeditiously, they have little economic significance. The third step, however, is entirely economic and is the real determinant of economic use of the resource. The third step is the application of a choice criterion in determining which uses (or rather the products or services supplied by each use) are most important. These uses must also be in line with the relative wants or desires of consumers of the products or services forthcoming from the uses. In applying a choice criterion relative weights or importance are placed upon use. This generally results not in a single use but an optimum combination of uses. Ordinarily, a single use will not be extended to the point where it curtails other uses below socially desirable levels.

For a given supply of water many alternative uses exist. Let me present a simple illustration of the problem in which, for purposes of simplicity, I will assume only two competing uses. Assuming that the supply of water is known, a set of production possibilities exist for its use. The water could be used entirely for one use, say irrigation. Another alternative might be to use all of the water for another use, say to produce an industrial product. Use of all the water for a single purpose would represent an extreme. Besides these two extremes many possible combinations of uses could be made between irrigation and industrial production. Assuming that both of these uses result in products for which there is a demand, the question is: Which alternative is the optimum or socially desirable combination?

An answer to this question cannot be given until a choice criterion is applied. That is, some social ordering or some relative importance must be placed on each of the many alternatives. The selection of alternatives must reflect the changing desires of the consumers. Normally the choice criterion employed is the pricing mechanism. Consumers reflect the relative importance which they attach to each alternative use of water by the prices they are willing to pay for the products forthcoming from the alternative uses. If all water available were used by private enterprise to produce commodities and services for consumers, given a set of prices, the private firms would produce commodities and services in line with consumer preferences.

Suppose that for the given supply of water we can produce 100 units of an agricultural product valued at one dollar per unit which would result in a total value of production of $100. The same amount of water will produce 40 units of an industrial commodity valued at $2.50 per unit resulting in a total value of production of $100. If consumers are completely indifferent as to whether agricultural products or industrial products were produced with the water, all of the water could be used for either product and the economic gain would be the same - $100. However, man does not live by bread alone. The consuming society says that it wants both agricultural and industrial products. They place a value on the industrial product that is 2 1/2 times the price of the agricultural product. This price ratio of 2 1/2 to 1 is the choice criterion which serves to indicate the optimum use of resources. It will be to the consumers advantage to substitute water used for agricultural production by water used for industrial production as long as the substitution ratio of agricultural products to industrial products is less than the price ratio of 2 1/2 to 1.

In our example the water supply is sufficient to produce either 100 units of agricultural product or 40 units of industrial product. If all of the water were used for either one or the other the total value produced would be $100. Society, however, wants some of both products. It is possible to produce 90 units of agricultural product and 10 units of industrial product which will have a total value of $115 with the supply of water available. In choosing this alternative, 10 units of agricultural product are being sacrificed to gain 10 units of industrial product. This is a substitution ratio of 1 to 1 which is less than the price ratio of 2 1/2 to 1 and therefore it is to society's advantage to make the substitution. Another alternative is the production of 70 units of agricultural product and 20 units of industrial product which results in a total value of production of $120. Here we sacrifice 20 units of agricultural product to gain 10 units of industrial product. The substitution ratio is 2 to 1, which, being less than the price ratio of 2 1/2 to 1, is advantageous. Still another alternative is the production of 40 units of agricultural product and 30 units of industrial product giving a total value of production of $115. In this case 30 units of agricultural product are sacrificed to gain 10 units of industrial product. This is a substitution ratio of 3 to 1 which is more than the price ratio of 2 1/2 to 1 and therefore is less desirable than the production of 70 units of agricultural product and 20 units of industrial product. This situation holds generally true for water use: increased diversion of water for one purpose entails increasing sacrifices in other uses. I again emphasize, water used for one purpose should not be extended to the point where it curtails socially desirable levels of other uses. In our example, water used for agricultural production should not be extended beyond production of 70 units of product so that it will not curtail industrial production below 20 units of product. In those alternatives, such as those used in this example, where products move into the market, the rule should be: use water for the purpose which has the highest marginal value product. If each unit of water were allocated in terms of its marginal value product, a maximum addition to the social product would be guaranteed in water use. It should be emphasized that it is the marginal value productivity and not the average productivity of water that is important. Use of the marginal value productivity takes into account that (1) the physical productivity of water may decrease as more is used for a particular product and (2) the price consumers are willing to pay for the product from a particular use of water may well decline where more of the product is forthcoming. Thus, the maximum value of water used for any purpose is determined by the marginal value product forthcoming from the last unit of water used. What does this mean and how does it work? Let us assume that in an arid region where crops cannot be grown without irrigation, 5 units of water are applied to an agricultural crop. The total value product for the first unit of water used is $100; the second unit, $180; the third unit $240; the fourth unit, $280; and the fifth unit, $300. The marginal value product for each unit of water use is $100 for the first unit; $80 for the second; $60 for the third; $40 for the fourth; and $20 for the fifth. If all of the 5 units of water were used for agriculture, the total value product would be $300 and the maximum value of water per unit used would be $20 since that is the marginal value of product from the last unit of water applied. This, however, would not be the most efficient use of the five units of water. A total value product of more than $300 could be obtained if the water were not all used for agriculture. Suppose that when used for the manufacturing of an industrial product the 5 units of water produce a total value of $55 for the first unit of water used; $100 for the second; $135 for the third; $160 for the fourth; and $175 for the fifth. Marginal value products are $55, $45, $35, $25, and $15. Since the marginal value products of the first and second units of water used for the industrial product $55 and $45, are higher than the marginal value products of the agricultural commodity forthcoming from the fourth and fifth units of water used, $40 and $20, respectively, it will pay to use only three units of water for agriculture and two units for production of the industrial commodity. Allocated in this way the total value product from both uses is $340 as compared to $300 when all the water is used by agriculture.

Hence, a general principle has been indicated for attainment of the first major condition - the efficient allocation between competing uses. The pricing mechanism can be used as the choice criterion reflecting consumer desires to water uses. However, for many uses of water, the pricing mechanism cannot be used as a choice indicator. For example, there is little opportunity to divert water from irrigation or power production to recreation purposes. In some instances, such as in the case of municipal water supply, prices paid for water are administratively determined and are not necessarily the prices people would be willing to pay for water produced by private competitive firms supplying water for municipal needs.

Although the pricing mechanism is an insufficient basis for final control of water use and allocation, the principle of the choice criterion should not be discarded. If the most efficient use or control of water is to be attained, the pricing mechanism as a choice criterion must be retained. Where the pricing mechanism is insufficient for measuring and reflecting the relative values of water in its different uses, other means of measurement must be found. Some means of measuring the relative values or weights for water uses where the pricing mechanism does not apply must be found so that relative values can be compared to the production possibilities of water and a choice of uses made in line with these two phenomena. In many cases of water resource development, optimum choices of use will need to be effected with some combination of price and legal mechanisms.4/

4/ For a more detailed technical discussion see Heady and Timmons, Economic Framework for Water Resources. Iowa's Water Resources. Iowa State College Press, Ames.

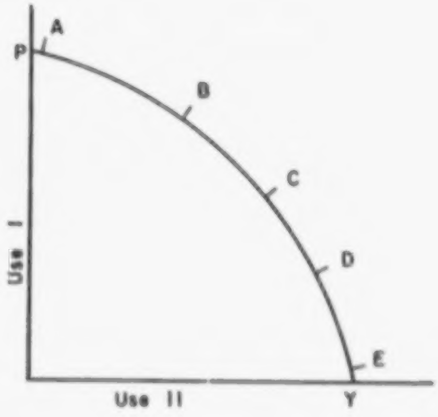
CONCLUSIONS

In this paper I have attempted to show how we might arrive at the total water demand for agriculture. Water requirements for agriculture, being of a physical nature, are not difficult to determine. After the requirements have been determined it is not a difficult task to determine the relative effects of water demand for agricultural uses on total water demand in a quantitative sense. This determination, however, is not the real problem. The real problem of effects of water is economic in character and is not so easily determined.

The real problem facing the American peole today in water resource use and development is: How should our scarce water resources be used to the greatest benefit to society? I have tried to point out some of the considerations that are involved in seeking an answer to this question. As I have indicated, insufficient knowledge is as yet available and considerable work will be required before a satisfactory solution can be attained.

TECHNICAL APPENDIX

A conceptual or schematic illustration of the problem concerned and its solution (i.e., the major condition of allocative efficiency) can be used to point up the requirements in attaining the most efficient uses of water. For the given supply of water, there exists alternative uses such as are illustrated in the following diagram.



Assuming that we know the supply of the water resource, a set of production possibilities exist for its use. (Here we assume only two competing uses.) The production possibility curve is labeled PY in the diagram. It shows all the possible combinations of the two uses which can be attained from the given stock or supply of water. The water might be used entirely for Use I. This extreme allocation of the given water supply to Use I would be represented by point A. Another alternative allocation would be point E; use of the entire water supply for Use II. But besides these two extreme allocations of water, we could select many possible combinations of uses. For example, we could produce much of Use I and little of Use II, as at point B; much of Use II and little of Use I, as at point D; half of Use I and half of Use II, as at C; or any of the other possible combinations along the production possibility curve PY. The optimum combination depends upon price ratios and substitution ratios. Profit is at a maximum if the substitution ratio between uses (or products forthcoming from uses) is equal to the price ratio. This principle can be illustrated with the following tabular example.

Selecting Alternative Use for Water

Production of I	Production of II	Substitution ratio: amount of I sacrificed to gain 1 unit of II	Profit or value of product with prices of $1 per unit of I; $2.50 for II
100	0		$100
		1	
90	10		115
		2	
70	20		120
		3	
40	30		115
		4	
0	40		100

Profits can be increased by extending Use II at the expense of Use I as long as the substitution ratio of Use II for Use I is less than the price ratio, (price of Use II ÷ price of Use I). Since the substitution ratio between the first two uses is only one, and is less than the price ratio of 2.5, the second combination is preferable to the first. The third combination (70 of I and 20 of II) also is preferable to the second since the substitution ratio of 2 in going between the second and third combinations, is still less than the price ratio of 2.5. However, the fourth combination is not preferable to the third since the relative amount of I sacrificed to gain one more unit of II is more than proportional to the greater weight placed on II by consumers.

If consumer preferences change so that Use II has 3.5 times as much value to them as Use I, the optimum combination then becomes 40 of I and 30 of II (i.e., with prices of \$3.50 for II and \$1 for I). Or, if preferences change to include a price of \$1.20 for I and \$0.60 for II (a price ratio of 0.5) the optimum combination is 100 of I and none of II, since the substitution ratio (in going from the first to second combination) is greater than the price ratio of 0.5, the relative importance placed on the product of Use II as compared to Use I.

The foregoing presentation is in the manner of a simple arithmetical example of optimum allocation of water uses. A more accurate analysis of the procedure involved can be shown by a series of production possibility curves and relevant community indifference curves.

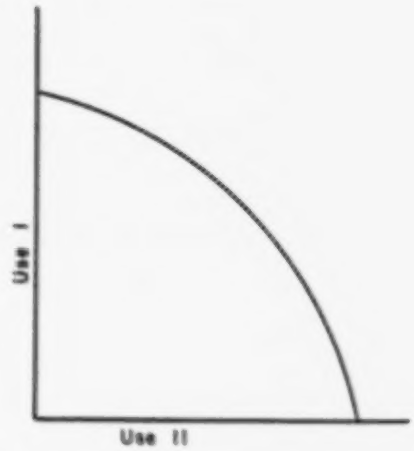


Figure 1. Production possibility for water uses

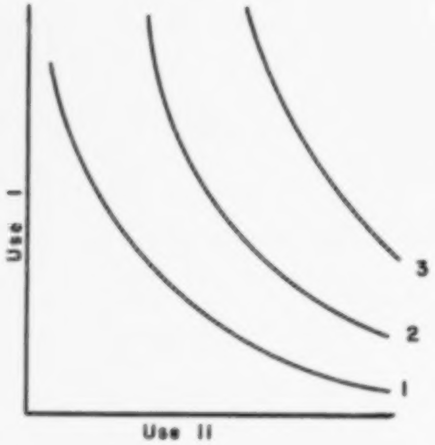


Figure 2. Indifference curves for relevant community.

Figure 1 includes production possibilities of the nature presented previously. Figure 2 includes a system of indifference curves for the relevant society of community. Each one of the system of indifference curves shows the combinations of products from Uses I and II which gives consumers the same level of satisfaction. The goal of consumers, of course, is to select a combination of products or uses which allows the highest level of satisfaction. Hence, in Figure 3, we superimpose the indifference system of Figure 2 over the production possibility curve of Figure 1.

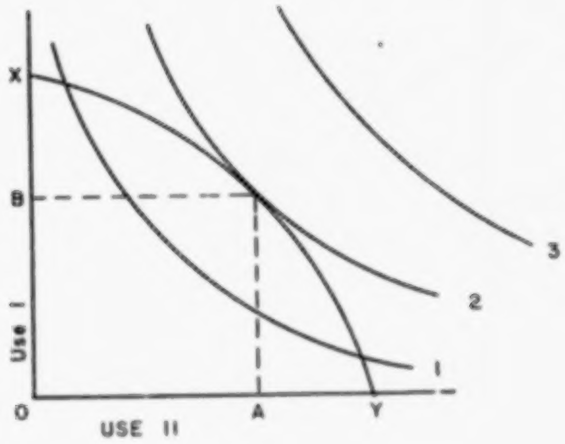
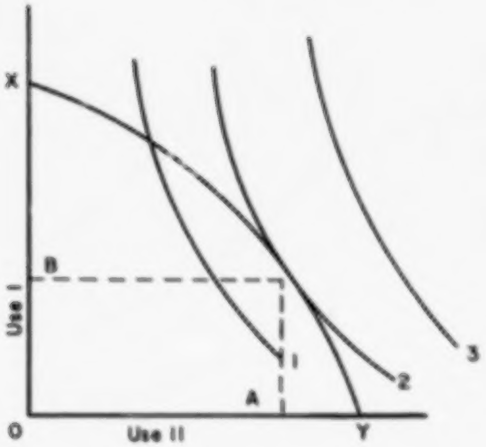


Figure 3. Combinations of production possibilities and indifference curves.

We then find the highest indifference curve (i.e., the highest level of satisfaction) which can be attained with the given resource supply. Indifference curve 2 is such a curve; this level of satisfaction can "just be attained" with the water available. While curve 3 allows a higher level of satisfaction, it cannot be attained with the given possibility curve. Curve 2 represents the optimum combination of Uses I and II by its point of tangency with the production possibility curve. At the point of tangency, the amount of Use I which must be sacrificed to gain an additional unit of Use II is just equal to the value which the consuming society attaches to Use II as compared to Use I. It is this ratio of preference or value for consumers of the products which is reflected back to the users of resources. Hence, the optimum combination of uses is not all of I or all of II, but a combination including OB of Use I and OA of Use II. If consumers changed their preferences for the two products in the direction of Use II, the entire family of indifference curves would take on a greater slope as shown in Figure 4, since the slope of the indifference curves expresses the relative preferences of consumers.



Hence the point of tangency would come closer to the aliscissa; relatively more of Use II and relatively less of Use I would be necessary to allow maximum consumer satisfaction or economic welfare assuming an equitable distribution of the product.

DISCUSSION

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At the outset, I wish to emphasize the importance of the role of water in the development of the West. Irrigation has made many areas in the West suitable for settlement, and it has created a frontier in which people have found the opportunity for profitable self-employment. Along with the growth in irrigation projects came many attendant benefits such as transportation facilities, schools, and community developments. The agricultural demand for water presently exceeds any of the other water uses except for power. Also, the season of maximum use is about 4 months which represents a much greater variation than for other uses.

In 1958 there were about 34 million acres of irrigated land in the United States of which some 30.5 million acres were in the 17 reclamation states. The National Resources Board estimates the ultimate irrigable area in the 17 reclamation states as 51,534,900 acres. Some others place the limit in the arid West at about 40 million acres. Potential irrigable lands in the East have been estimated at about 125 million acres. The acreage which will eventually be irrigated will depend upon the availability of water.

The limit of water supplies that may be obtained by simple gravity diversion of natural flows has for all pratical purposes been reached, and the remaining potential irrigation expansion from ground waters is relatively small. Any significant future expansion of irrigation in the West will depend upon the more expensive reservoir storage and high lift pumping developments. Many transmountain diversions are in use, and more planned, to bring new areas under irrigation.

Dr. Eichberger's paper has brought out the importance of water to agriculture and presents some water-use figures on a per capita per day basis that at first glance may appear to be misleading. In the West, application rates have ranged from 2.2 acre-feet per acre in the Rio Grande Valley to 6.1 acre-feet per acre in Idaho. Much higher rates have occurred in isolated instances. The average annual diversion requirement in the arid West is about 4 acre-feet per acre. In the humid area the rates of application are usually much lower than those in the arid West and vary from 0.5 to 1.25 acre-feet per acre. Application rates are governed by (1) the availability and cost of water, (2) local and climatic conditions, (3) methods of application, (4) soil types, (5) crops, and (6) quality of the water.

On the average, at least 10 acre-feet of storage are required for each acre of land irrigated from storage. The reason for such an amount of water is evident when we consider the water losses. In some reservoirs evaporation loss alone may account for almost 50% of the stored water. Other losses which must be considered in connection with irrigation projects include (1) main canals, 15 to 40% of water diverted; (2) laterals, 5 to 35%; (3) farm systems, 5 to 10%; (4) seepage, 5 to 60%. The Bureau of Reclamation estimates that current research in water saving devices may lead, within the next 20 to 40 years, to water savings in the West in the magnitude of at least 10 million acre-feet of water annually. With the present rising demand for water, and the associated costs, it is imperative that our water resources investigations be concerned with the future, to make the most economic use of the available water.

Aside from the total water required for direct use in irrigation, there is the need for additional water to meet the domestic water requirements on the individual farm units and also increased municipal and industrial water supplies to support the segment of the population and industry engaged in supplying services and materials required by agriculture, as Dr. Eichberger has mentioned. Although these additional water requirements are necessary, it must be realized that a higher quality of water is generally required than that utilized for irrigation purposes. In order to get an acceptable water for domestic, municipal, and industrial purposes an additional water source other than that which supplies the irrigation requirements may be necessary. Considering this additional water requirement the affect of agriculture on water demand may be increased many-fold.

Much of our present farmland adjacent to urban population centers is being lost to urban and other nonfarm uses. According to the Soil Conservation Service, an estimated 1.1 million acres of farmland are converted annually to municipal, airport, highway, and other nonagriculture uses. In many areas, the expansion of municipal and industrial developments into the agricultural districts will necessitate the conversion of the irrigation water rights to meet the municipal and industrial water demands.

A report prepared by the United States Department of Agriculture for the Senate Select Committee on National Water Resources disclosed that the rapid population growth would soon place this country in a position of farmland shortage unless timely offsetting actions were taken. In this report the food and fiber needs, export and import requirements, and the farm production potentials were appraised.

Population growth to 330 million persons, plus a 12% increase in per capita consumption, will boost the total requirements for farm products to a level double that of the present. Limited land use capabilities will preclude converting as much land as will be needed, and per-acre crop yield increases of 76% will be necessary to meet the expanded food and fiber demands in year 2000.

The short range projection cited by the report indicates that by 1980 the present population will have grown to 224 million with commensurate requirements for additional agricultural products. To meet these needs will require crop yields 41% above the present, and a net addition of 20 million acres of cropland. Research, education, and adequate water supplies will be necessary in order to realize the required crop yield. It is said that one acre of irrigated cropland will produce, on a national average, the equivalent of three acres of nonirrigated cropland.

The widespread effect of technological innovations on agriculture can perhaps be best summarized as Senator Kerr has done in his book "Land, Wood, and Water." In 1850 man supplied 15% of all the energy required in agricultural operations, animals supplied 79%, and machines 6%. Today man supplies 3%, animals 1%, and machines 96% of all the energy required.

In the projected development of new lands in the western states, the Bureau of Reclamation sees about 230,000 new farm units with an accompanying increase in farm population of about 800,000 people. The opening of new farmlands by irrigation projects provides a stimulus to economic activity in the form of new job opportunities and income in related and dependent industries. The total estimated farm delivery requirements of water for the potential projects in the western states is about 70 million acre-feet per year. To this must be added the water losses that are associated with storage and transmission to the farm units.

Cropland in use in the United States has fallen to about two acres per person from a ratio of 3.7 in 1900. By the end of the century this ratio may be approaching the one acre per person level, even if the foreseeable cropland additions are achieved. Advances in farm technology will be required to produce the necessary foods and agricultural products to support the future population.

The impact of irrigation on the quality of water has not been given enough consideration by the water resource developers or the irrigation farmers. That portion of the irrigation water diverted to the croplands that returns or becomes available for additional use varies from area to area and may range from 0 to 50% of the applied water. In addition, the level (concentration) of salinity in the return flows is increased by the leaching of soluble salts from the soils. Not enough is known about the quantity and quality of the return flows from irrigation projects. If water is plentiful farmers tend to over irrigate in both frequency and depth of application. In some places, the quality of irrigation water also affects the requirements and as much as 20% more irrigation water is needed to control the accumulation of salts in the soils.

The efficiency with which farmers apply their irrigation waters to their crops may range from 15-90%; that is, from 15-90% of the water turned into the field will be made available to the plant roots, the remainder being lost as runoff, deep percolation, and evaporation. An increase in farm efficiency will result in an increase of irrigated areas and thus increase farm income.

Establishing a priority of water use is necessary in any water resource investigation. The point has been reached where any use of water that does not give an optimum economic and social return is wasteful. Following establishment of priority for human consumption and flood control the ordering is much more difficult, as Dr. Eichberger has emphasized in his paper. The level of water costs may effect not only the pattern of use but also the effective supply. Certain uses can bear higher costs than others and the introduction of these uses may influence priorities. In many cases industrial water users may justify an investment in the provision of an adequate water supply and, if given priority, can even make available increased supplies for irrigation and other purposes as a result of the concomitant installation of pipelines and other facilities which, in the absence of industrial developments, would not be economical.

Letting the pricing mechanism, and where inapplicable legal and social means, be the guiding criterion for resource allocation is the democratic way of life; however, other items such as recreation and fish and wildlife must also be considered. In many of our irrigation storage reservoirs recreational and fish and wildlife benefits are taken into account in determination of the benefit-cost ratio. Fluctuation in the water level of the storage reservoirs introduces some undesirable conditions but there is still a benefit that may be associated with the available water supply for recreational activities. Compatability of irrigation and industrial water users will be dependent upon the type of industry and its location as well as the depletion of the water resources and deterioration of the water quality by the water user.

The prices paid for irrigation water are dependent upon the project construction costs and the annual operation and maintenance costs. Some of the irrigation projects now being developed will require the basin accounting application; that is, power revenue from some installations must be used to repay project costs and the irrigator primarily will be meeting the operation and maintenance costs. In other words, a project may not be self-liquidating by itself. From a value standpoint, the biggest contribution of irrigation projects in the western states is in the category of fruit, vegetable, and other specialty crops. The environment of the western irrigated area is especially favorable for these crops.

The pricing mechanism and the marginal value productivity cited in Dr. Eichberger's paper indicate the necessity of a thorough study before water allocations or priorities are determined. However, it must also be realized that application of any method for determination of water priority must be applicable to the area under consideration. The same principles cannot be universally applied. In some instances the economic and social value may extend over a much larger area than the immediate area where the water priority is to be established.

In one of the reports to the Senate Select Committee on National Water Resources, projected figures are given on the value added per acre-foot of water. -

> "The average value added per acre-foot of water required in 1980 for the southwest agricultural projects ranges from $28.00 to $62.00 based on 1954 prices whereas for selected manufacturing uses the average value ranges from $72.00 to $7,435. On this basis, one can assume that agriculture will be gradually displaced by other uses."

It has been said that, while 1,000 gallons of water can produce about 10 cents worth of agricultural crops, the same 1,000 gallons of water can make $11.70 worth of manufactured goods.

As Dr. Eichberger has pointed out, "The real problem of effects of water requirements for agriculture on total demand for water is economic in character and is not so easily determined." The economic and social values associated with the agricultural production may be nationwide, whereas some industrial operations may be restricted to a small segment. The increasing population will require doubling of the crop production, and livestock products must be more than doubled. As the competition for water becomes more acute our water resource development and use must recognize the desirable and necessary water-use priorities. Cooperative action as well as state and Federal legislative guidance will be required to accomplish the necessary water resource developments.

GENERAL DISCUSSION

SVORE: I was a little surprised at Garry's comment there that a thousand gallons of water will produce ten cents worth of agricultural products. Is that what you said?

FISK: Yes.

SVORE: Then in applying the extreme of 18 acre-feet per acre, you would have to get $540.00 off that one acre.

FISK: This is for a 2-crop season.

SVORE: I realize that ten cents a thousand gallons is not an excessive amount to pay for municipal water. To ever get anything in the vicinity of $540.00 off of an acre of crop land is rather excessive. The reason I got up, however, was something else to make comment on. I'm wondering, Bill, do you feel the economics of agricultural use of water versus municipal and industrial uses of water - and I realize I'm speaking of this part of the country and the West - even though they are overwhelmingly in favor, if industry and municipalities will ever overcome the political and the laws that are now established in creating priorities in water rights for agricultural use? Would you care to comment on that?

EICHBERGER: Jerry, I think this: I think that there's evidence that this thing has already moved. I, too, was with the Bureau of Reclamation for a number of years and in the West; agricultural uses had a priority.

SVORE: They've got it now.

EICHBERGER: They've got it now, that's true, but I would think that as people demand water for other uses, although not necessarily for higher value, that laws and regulations will be changed. I think it's evident.

THOMAN: One question on the fertilizer - we had some test wells down in Florida where they applied 3,000 pounds per acre, and we sampled the water - it only goes down about 10 feet and we weren't able to pick up any evidence of fertilizers in the water. It's continuous irrigation and it goes down through this very porous limestone rock very fast, but we couldn't get any in there.

TORGET: I may have a rather unfair question, Bill, but I don't mean it to be. Frank mentioned this morning about this part in Missouri that was really nosediving downward and then I'm aware that Ken Nobe made a study or a part-study there, and that took 30 man years to make.

Frank has on a smaller area, but not 30 man years. You did say something about the production - the agricultural production of the country may, in terms of employment, may very well go downward and then upward a little. This was one assumption you thought might be realistic. Now Frank has to come up with something on agriculture in this area. Since he has a very short time to make an analysis of agriculture in this kind of an area, what might he use here that would be short of the kind of study that Ken did? I realize this is an unfair question, but I thought Frank, for one, would like to know.

EICHBERGER: I don't regard the question as unfair. It's a problem we're all facing in this work. We are limited on time and we have to make rather quicky analyses. I think that what we should do is to get a pretty good picture of what has happened and what is happening now. The Department of Agriculture assumed (and I'm not questioning those assumptions) that, I believe, 1980, we will have reached the point where we will no longer have surpluses. I think we take into account these assumptions. Taking into account the change in size of farms and number of farms, that we can come out with figures for agricultural employment that do not require the 30 man years that we put in on the Potomac.

WITHEROW: He knew what we did Tuesday, which we now wish we had done three months ago, and that is to get some expert advice in this field to start at the right place. Certainly we would have been much better along at present had we had expert advice to start with.

EICHBERGER: I think that's right, Jack. I think we spent a lot of time just getting handles. Sometimes we can get some help to put those handles on.

NOBE: I think I have to set the record straight on one thing. This 30 man years included a lot more than just economic evaluations. This included the whole effort of the Department of Agriculture, Forest Service, Soil Conservation, which the dams were designed, allocation of water - I'd venture to say if you took it down to the economic junk alone, it would be more like 3 man years - but this study that went on for the last 6 years, I'd like to add one thing to that, that I consider a possible solution - and I think I can say this inasmuch as none of us are experts. In all these inter-relationships that have to be taken into account, I would strongly recommend a base study done outside the Department for a particular project; the data in such a base study begins in such form that we can in turn convert it into water use and water quality requirements.

THOMAN: You are suggesting an economic base study be made outside of DHEW PHS?

NOBE: That's right. Because I say this for one reason: The sort of thing that Jack has run into. He's not an expert on agriculture, yet he's faced with evaluating it. Once he has the data, I'm sure he can do this, but if he's depended upon to make the evaluation, some of us are going to get in hot water.

THOMAN: I'm not in a position to speak for the Public Health Service or the Department or anything, but personally, I take a dim, dim view of doing some things outside. This hasn't been too productive in other areas.

WEISER: I don't take such a dim view, because I think at some point we must rely on the technical competence of some of our fellow workers in the bureaucracy, but we ask them to rely upon us at times, have confidence in us, our professional integrity, our ability. And I think that a duplication of these efforts is one of the drawbacks of the bureaucracy, and I think we can avoid it when we're speaking about some of the problems inherent in the time element here, and that we can, in fact, avoid some of that by dependence upon some of the other technical competence.

SVORE: I don't like to get up again on this point, but I think there's one other question I'd like to ask Bill. If the municipal and industrial interests that we have are in competition for water, which we certainly are in this part of the country, I think that this - if we're going to have such economic studies outside of PHS, we should have some insurance that we're going to have the right type of analysis and there is competence outside. Now, Bill, you mentioned that you were with the Department of Agriculture, also with the Bureau of Reclamation. I would like to pose this little question to you, on whether or not either of these Departments took this sort of situation into consideration. Garry and I, and a couple of other people in this room, week-before-last were at a meeting where the situation in Yuma, Arizona, was mentioned. As I understand it, Yuma gets its water out of the Colorado. Last October the water situation was satisfactory - the chlorides were within the Public Health Service drinking water standards, and started to go up, and as of now, chlorides are running about 800 parts per million at the Yuma intake. The irrigation project is on the Gila River. The chloride content in the Gila, which were largely the return flows from the irrigation project - were 26 parts per million. The Bureau, of course, defended the situation by saying that Yuma owes its existence to the irrigation project, and this is a debate, probably, in philosophy, that doesn't enter into the picture. But, if this is the case, and this is what is going to happen in competition between irrigation and municipal and industrial water, does the Bureau and the Department of Agriculture consider negative benefits in the water quality area when they determine the justification for irrigation.

EICHBERGER: No, they don't, in general. Neither of the Departments engaged in developing water resources for agricultural use considers negative benefits from the water quality standpoint.

SCHEIDT: I just want to comment a little on the question that Jerry raised, because rather fortunately or unfortunately, - nevertheless, I at one time had substantial to do with running a forty-seven, Bureau of the Budget. I would point out that it was the intent that these negative benefits should be taken into account. That must be a part - an oversight on the part of the Agency. They ought to be taken into account. I'm sure they do.

EICHBERGER: I think this, Mel, anything that does a damage from one use must be considered as a negative benefit or as a charge against the development.

FISK: On one particular project in which we put in our recommendations, the Bureau reflected a cost in their project cost which would more or less indicate that the downstream city in one case has to go to more sewage treatment or to improve their sewage treatment - secondary treatment, they'll have to go to chlorination. They suggested that their project cost reflect this increased cost in their report. In these reports the Bureau also writes a summary which goes into the body of their public health report - so in their summary they mentioned in there that the State law existing in these two States was concerned with this particular project, but that the Bureau had no legal responsibility to bring in these costs. Period. That's the way they more or less felt. They did wind it up that since it was going to come into account, Congress would have to include this addition in their allocation for the project. The moral responsibility exists - they did not recognize such.

ESTIMATING FUTURE WATER DEMAND

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INTRODUCTION

This paper will present some of the problems typically encountered in making estimates of the water requirements which may be expected to accompany the projected populations and economic activities, previously discussed by Mr. Torget. The paper is intended to serve as a basis for discussion leading to conclusions. It is pointless to deny that I already have certain personal convictions on the subject---as the reader will no doubt detect.

GENERAL OUTLOOK

We believe that the planning of water resource utilization can and should be approached with optimism. A noted spokesman has been widely quoted as saying, in speeches made throughout the state of Texas this past year: "Within the next 50 years, the number one problem in Texas may well become where to get a good drink of water." Not to disparage the speaker, whose purpose to get the attention of a well-fed luncheon audience was admirably served by this catch phrase, it must be pointed out that drinking water is a negligible part of total water demands. To be sure, a prudent man would not sit down in the middle of a desert, waiting either to have water brought to him or die of thirst. But then, he never could do that in the past.

There is, happily, a growing awareness that water is a commodity like any other, and can become responsive to the same economic laws that govern other goods and services. This viewpoint was ably presented by Mr. Hines, in his paper, "Role of Price in Water Resource Allocation." [1]

This paper is written in the environment of Region VII and some of its statements may not apply to other parts of the country.

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[1] Hines, Lawrence G., "Role of Price in Water Resource Allocation", Journal of the Sanitary Engineering Division, ASCE, January, 1960.

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With that qualification, it can be said that there is ample reason to expect that water can be made available in quantities sufficient to meet any reasonable projection of demand, at prices within economic range. This is said in full knowledge of, and in spite of, the voices of those whom John Vandertulip [1] has called "Criers of Doom."

THE COMPONENTS OF WATER USE

Water serves many purposes, and this discussion is confined to the projection of municipal-and-industrial water requirements. The hyphens are there to emphasize that we seek a single final answer, whose total value will include all of the water uses which the words municipal and industrial, together or separately, connote.

The first sentence of the report to the Select Committee, Print #7, [2] reads in part: "Presented... are data on the quantities ... of water presently supplied through municipal systems... (and) estimates of the quantities... required for municipal purposes in ... the year 2000...." (Underlining supplied.) I suggest that the author changed horses in midstream of that sentence. Two examples will illustrate the distinction. At Tulsa, Oklahoma, 38 per cent of the present output of the municipal water department is sold to two oil refineries. At San Antonio, Texas, the largest department store has its own well, as do many other commercial establishments and some residences. The first example illustrates municipally-supplied industrial water, and the second, "self-supplied" municipal water.

It is admitted that defining municipal water as water supplied through "organized community water facilities" [3] has advantages. It facilitates processing of reported data by machine methods, and it subdues the element of judgment in statistical analyses. Nevertheless, it is believed that a preferable basis for future projections is to subdivide water use according to purpose, and not according to the modus operandi by which the water is delivered to users.

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[1] Chief Engineer, Texas Board of Water Engineers

[2] Future Water Requirements for Municipal Use. Report by the Department of Health, Education, and Welfare, to the Select Committee on National Water Resources, United States Senate, published as Committee Print No. 7, 1960.

[3] Municipal Water Facilities, Communities of 25,000 Population and Over ..., U. S. Public Health Service, January, 1958.

Fortunately, it happens that in many cases, and perhaps in a majority of cases, those industries whose water demands are significantly large, have their own facilities. The remaining industries are either so small, or so much a part of any typical community, that their water use can, without serious error, be included with other usage in a single municipal figure. But the investigator should be on the lookout for exceptions to this generalization, and make appropriate adjustments.

For the type of water resource planning with which we are concerned, there will be no "self-supplied" users. The goal of resource planning is to present an over-all appraisal of supply and demand for a study area. Supply can come only from one or both of two sources--surface and ground waters. Both sources are supplied by nature, and man can only effect some modification in the areal and temporal distribution. Of course, some large streams may require little or no artificial regulation, but this in no way alters the basic truth. Water may be self-pumped or self-piped---but it will not be self-supplied.

For projection purposes, the separation of water demand into a multiplicity of component parts is of questionable merit. The historical records of municipal water use are of dubious accuracy even for the total quantity used. Few operating water companies can do more than guess at how their total output is divided among different purposes. Evidence for that statement is to be found in examination of the 1957 Inventory of Municipal Water Facilities. 1/

Columns 15 and 16 of the Inventory report the answers to the question of how total output is divided into four parts: Domestic (Residential), Commercial, Industrial, and Public-and-other. Approximately 62 per cent, of 580 reporting communities, either did not answer the question or gave incomplete answers. Another 13 per cent gave answers whose sum does not equal the reported total output. Three examples will be cited to support question of the validity of answers for the remaining 25 per cent.

The City Water Board of San Antonio, Texas, was among the 25 per cent reporting consistent answers. I was employed there at the time of the inventory. We were justifiably proud of the records kept by the Water Board. But those records were not kept in such manner as to yield an answer to the question of four-part breakdown----somebody guessed at it.

Another city reported total output of 10 mgd, divided 3-3-3-1; a breakdown of beautiful symmetry but doubtful validity.

1/ Ibid.

In sharp contrast to the reports from other states, in Wisconsin every city but one gives a consistent breakdown. This means either that Wisconsin operators are far ahead of their neighbors in detailed accounting for water, or else the state data were arbitrarily adjusted for consistency in a central office.

Notwithstanding what has been said, further study of the breakdown and pattern of water use is worthwhile. I believe it will be profitable to pursue local studies of an intensive nature, as a complement to the extensive coverage of nationwide inventories.

FACTORS AFFECTING WATER DEMAND

In the language of the mathematician, water demand will be treated as the dependent variable. Independent variables or parameters, upon which it depends, may be listed as follows:

1. Population.
2. Time (trend).
3. General state of the economy.
4. Living standards of families.
5. Climate.
6. Size of city.
7. Price of water.
8. Type and size of industry.
9. Accuracy of measurement.

Ideally, the scientific approach to investigation would be to allow each parameter to vary in turn, while holding all others fixed, and to measure the observed effect. Unfortunately, it is not possible to isolate any single variable completely from the others---nor is it possible to use another technique common in model studies and group them into dimensionless combinations, thereby reducing the number of independent variables.

An effort has been made to find examples for which one parameter was of predominant influence---either because the others did not vary or because the observed effect occurred in spite of counter-influence of other parameters. As each parameter is discussed, the examples will be presented.

1. Population

Because population is the most important single factor affecting municipal use, it is customary to express the ratio in gallons per capita day (gpcd). Except as qualified, other variables will be examined as to their influence on per capita use.

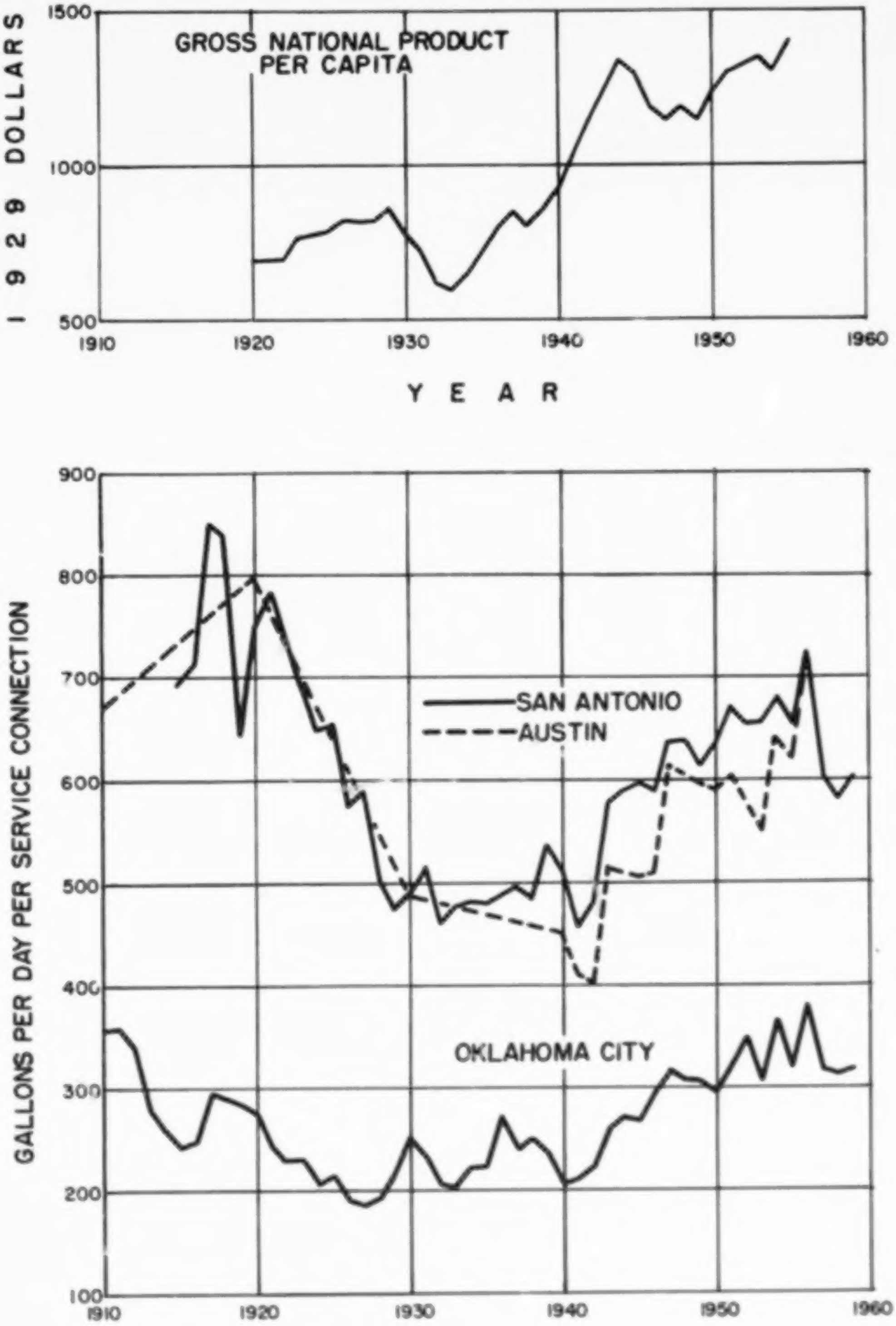
GROSS NATIONAL PRODUCT PER CAPITA
1 9 2 9 DOLLARS
1500
1000
500
1910
1920
1930
1940
1950
1960
YEAR
GALLONS PER DAY PER SERVICE CONNECTION
900
800
700
600
500
400
300
200
100
SAN ANTONIO
AUSTIN
OKLAHOMA CITY
1910
1920
1930
1940
1950
1960
YEAR

FIGURE 1

2. Time

Figure 1 shows the trend of municipal water use at Austin, San Antonio, and Oklahoma City. Gallons per day per service connection, rather than per capita, were plotted because records are available directly in that form for two of the cities. For Oklahoma City, pumpage data, but not the number of service connections, are available for each year. Because of necessary adjustment to permit plotting on a comparable basis, the Oklahoma City curve should not be considered definitive except as an indication of general trend. Our primary concern here is the general shape of the trend curves. The U-shape which is characteristic of all three records leaves wide latitude for opinion as to what the future trend will be. For extrapolation 50 years into the future, it is desirable, on one hand, to consider the longest available period of past record. Examination will show that a line drawn approximately through the earliest and most recent points would incline downward into the future.

On the other hand, a sharp upward trend is evidenced in the last 25 years. The slope of this 25-year trend translates into an average increase in per capita demand of one to one-and-a-half gallons per day per year. Apparently, this is the evidence upon which many forecasters have predicted future acceleration rates of such magnitude.

A third possibility exists, which is not shown on Figure 1. Records of the last four or five years exhibit a level trend.

Somewhere among the possible extremes lies the most probable answer. In my own opinion, it is unreasonable to expect the acceleration rate of the past 25 years to continue unabated for fifty more years. But I must disagree with those who would ignore it entirely.

In reaching a decision, it would be most helpful to know the causes of the shape of the trend curves. Here the impossibility of isolating the variables becomes apparent.

Conjecturally, the downward trend of the early years reflects increase in metering. Unquestionably, metering has a significant effect on the water usage. When it is not metered there is little incentive to call a plumber to repair leaks--and a leak can easily waste far more water than is beneficially used.

Possibly the low point in the mid-thirties and high point of the mid-fifties reflect the influence of our third variable, the general level of economic activity. In pursuit of this idea, the graph of gross national product was also plotted on Figure 1. The low point of the curve corresponds to the middle of the Great Depression, and time may show the high point to coincide with the peak of a boom period. However, the hypothesis doesn't stand up too well under closer examination, especially in the period from 1920 to 1935.

4. Living Standards of Families

Table 1 and Figure 2 show the result of a part of an intensive study of water use patterns in San Antonio, Texas. An unusual opportunity to isolate one variable from the others is made possible by the fact that, since 1957, the San Antonio Water Board has kept separate records of consumption in each Census Tract. The city was divided at the time of the 1950 census into approximately 100 of these tracts.

Ten Census Tracts were selected for investigation. These tracts were chosen because: (1) each tract is predominantly single-family residential, with a minimum of commerce and no industry; (2) the ten tracts cover the range from luxury to sub-standard class of neighborhood; and (3) each is homogeneous with respect to its economic class.

1960 populations given in Table 1 are the preliminary United States census values, obtained through the courtesy of the San Antonio Chamber of Commerce. Populations for other years were obtained by interpolation, using number of service connections as a guide. Water consumption data are from the records of the City Water Board. Property values were obtained from records of the Bexar County Tax Assessor-Collector. Assessed valuation was first determined by averaging approximately fifty random samples for each tract. The average assessed value was then divided by 28 per cent, on the advice of tax office personnel, to convert to actual market value.

I would have preferred using per capita income instead of property value as a measure of the standard of living in each Census Tract---but the figures are not yet obtainable from the Census Bureau. Nevertheless, the high degree of correlation between standard of living and per capita water use, and the tremendous influence of standard of living, are clearly apparent in Figure 2.

Annual rainfall was above normal in all four of the years of record.

The price of water was about 30 per cent higher in the two tracts, E-1 and E-2*, than in the others. This is because they are

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* Census Tract designations used herein are not the actural tract numbers.

Table 1
Residential Per Capita Water Consumption
San Antonio, Texas

Census Tract	Average Property Value	Population				Average Water Consumption, gpcd			
		1957	1958	1959	1960	1957	1958	1959	1960
A-1	$ 3,000	14,000	14,000	14,000	14,000	60	59	70	60
A-2	4,400	6,400	6,500	6,600	6,700	83	78	84	84
B-1	5,900	4,400	4,420	4,350	4,300	106	98	101	96
B-2	6,400	4,440	4,450	4,420	4,440	114	107	110	109
C-1	8,600	5,040	5,040	5,040	5,040	127	111	113	111
C-2	9,700	10,320	12,180	13,900	15,200	143	94	98	97
D-1	19,700	5,230	5,970	6,950	7,760	195	190	208	208
D-2	16,600	4,900	5,760	6,760	7,150	186	157	202	183
E-1	20,800	5,040	5,130	5,220	5,600	252	212	224	256
E-2	21,400	2,590	2,530	2,480	2,440	262	225	260	280

separately incorporated satellite cities and are charged the outside-city-limits rate of the San Antonio waterworks. It appears that, for this luxury class, the premium price of water didn't noticeably affect its use.

5. Climate

Several investigations of the relationship of per capita use to rainfall have been made in the Region VII office. The results can be summarized by saying that, when annual rainfall is more than about 45 inches, no discernible effect is caused by further increase in amount. Below 45 inches per year, there is a noticeable effect, per capita demand at 15 inches of rain averaging about 20 to 30 gpcd higher than the demand at 45 inches.

One illustration of observed effect of rainfall will be presented in the discussion of the next parameter, size of city.

Before leaving the subject of climate, it is appropriate to suggest that more consideration should be given to drouth frequency analysis in the study of both supply and demand. Since the purpose of storage impoundment is to assure the supply of water during drouth periods, it is logical to estimate what the demand will be under the design drouth condition that is used in reservoir yield studies.

The governor of Texas said recently that the drouth of the middle fifties was the worst in 600 years. Without questioning the accuracy of estimate of that recurrence interval, it can be questioned whether our "prudent user" would be willing to pay the cost of avoiding some curtailment in water usage once every 600 years. Statements of dependable yield from a reservoir should be accompanied by a statement of the drouth frequency, or recurrence interval, used in the analysis.*

6. Size of City

Figure 3 was plotted from data collected for a 46-county regional study being made for the Trinity River Watershed and adjoining areas. Each point represents the average per capita use of all community water systems (for which records are available) in a county. Included in the group are Harris County (Houston), Dallas County, and Tarrant County (Fort Worth).

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* Although low-flow augmentation is outside the scope of this paper, the same viewpoint applies.

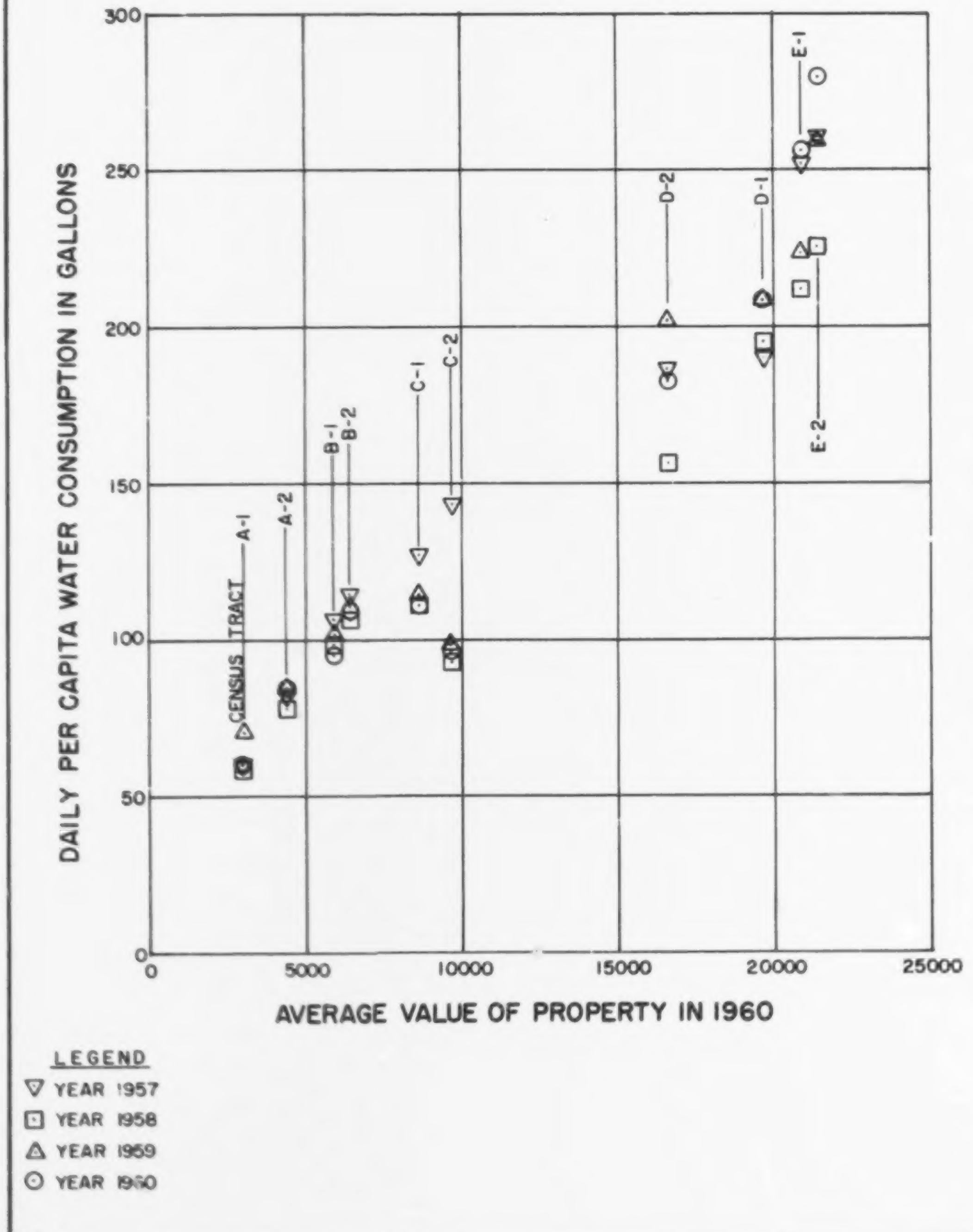
DAILY PER CAPITA WATER CONSUMPTION IN GALLONS
0
50
100
150
200
250
300
0
5000
10000
15000
20000
25000
AVERAGE VALUE OF PROPERTY IN 1960
CENSUS TRACT
A-1
A-2
B-1
B-2
C-1
C-2
D-2
D-1
E-1
E-2
LEGEND
▽ YEAR 1957
⊡ YEAR 1958
△ YEAR 1959
⊙ YEAR 1960
WPK

FIGURE 2

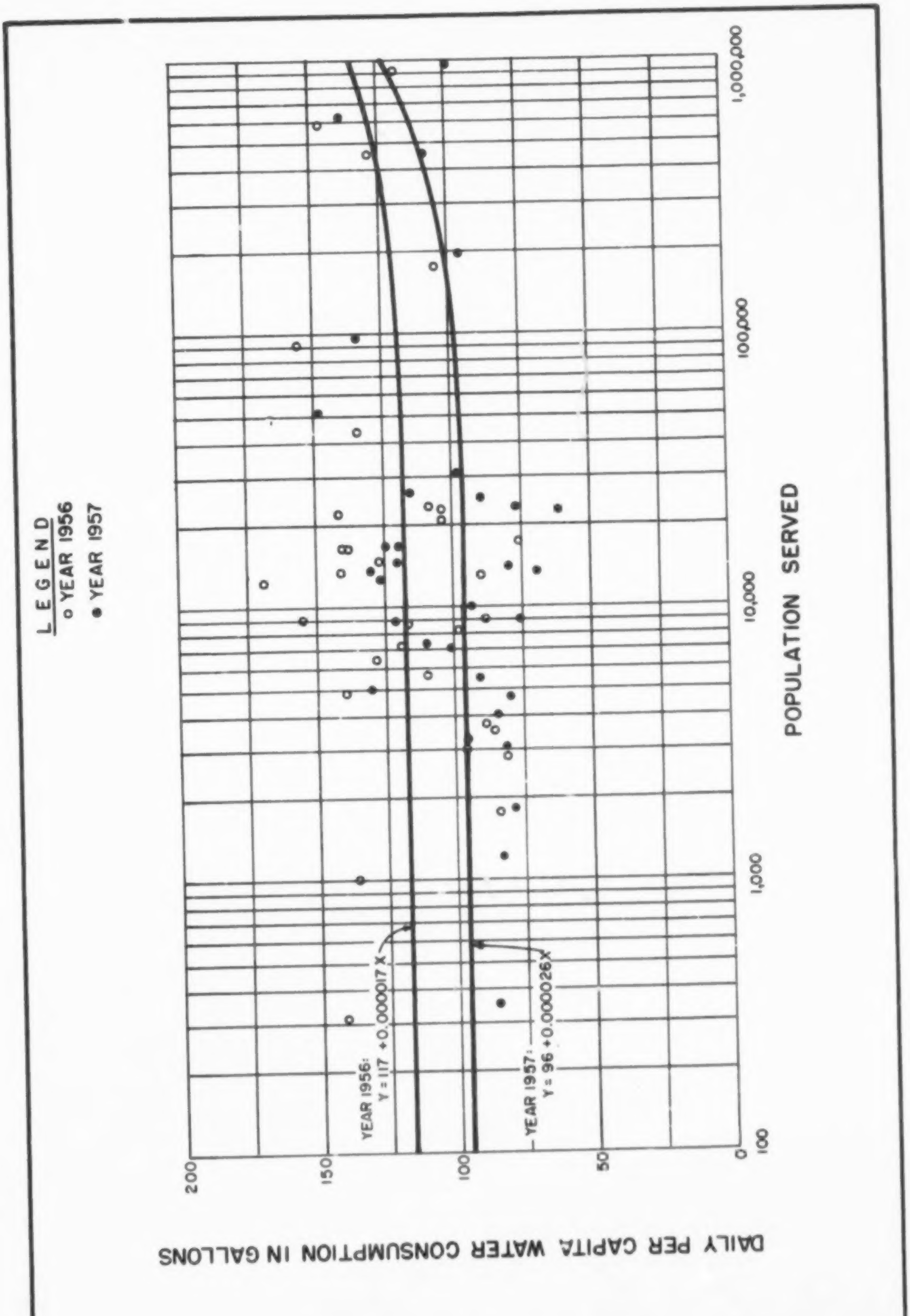
LEGEND
○ YEAR 1956
● YEAR 1957
YEAR 1956: Y = 117 + 0.0000017 X
YEAR 1957: Y = 96 + 0.0000026 X
POPULATION SERVED
100
1,000
10,000
100,000
1,000,000
DAILY PER CAPITA WATER CONSUMPTION IN GALLONS
0
50
100
150
200

FIGURE 3

The fortuitous occurrence of an abnormally wet year immediately following a record drouth year (1956) offers a good opportunity to see the effect of rainfall extremes. It will be seen that per capita demand in 1956 averaged about 20 per cent higher than in 1957.

The astonishing thing about the data plotted on Figure 3 is the indication of limited effect of size on per capita demand, even though sizes range from a thousand to a million people. Statistical regression lines for each year, and their equations, calculated by least squares, are shown on the graph. They were calculated because we didn't believe our eyes, and they are not recommended for general use. I am not ready to say that this evidence shows that per capita use does not increase with size of city---but I am no longer willing to accept such an assumption without doubts. Perhaps the country town is disappearing, along with the country girl.

7. Price of Water

In considering the effect of price on water demand, three basic facts should be kept in mind. These are: (1) it is delivered price, not cost of source development, that is significant; (2) for legal, political, and social reasons, the role of price has been greatly restrained; and (3) it is incorrect to generalize that the unit price of water will go up everywhere.

The cost of source development is usually a small part of delivered price of water. In an increasing number of cities the water bill includes a sewer service charge, which may or may not be separately itemized. (In Dallas it is not.) Some cities subsidize the cost of water service from general tax funds; others use water sales as a source of municipal revenue for other purposes.

Legal aspects can be illustrated by the following example. One might ask why the holder of a water right on the Texas coast persists in using the water to grow rice when the dollar return would be much higher if it were used in industrial production. The answer is that he possesses only the right to use the water for a specified purpose, irrigation, and not the authority to sell it. Society as a whole might gain from reallocation of scarce water to higher-yield usage---but the incumbent water-right holder stands to lose what he has and gain nothing. The pressing question is, "Whose water is it?." Waiver of claim by the Federal Government still leaves the gamut of claimants, from private citizen, to city, to county, to water district or river authority, to state.

The costs of impoundment, treatment, and transmission of water respond dramatically to the effect of mass production. Many a small town is experiencing critical problems of high-cost water precisely _because_ the demand is small.

I shall resist the temptation to elaborate further on a pet subject, and simply say that price is expected to play a role of increasing importance in the future.

It is difficult to find evidence of significant effect of price on water usage in Region VII. Apparently this is because the cost of water is a small part of either the cost of living to families or the cost of production in industries. Only one example has been found for which a comparison can be made---the cities of Abilene and Brownwood, Texas. Investigation of the records disclosed the following facts:

1. The cities are located about 80 miles apart.
2. Abilene is three times as big as Brownwood.
3. Abilene is growing rapidly, while Brownwood lost population in the last 10 years.
4. Rainfall at Abilene averages slightly less than at Brownwood.
5. Per capita income is higher at Abilene.
6. Neither city is highly industrialized.
7. Contrary to expectations, per capita water use for several years past has been consistently higher at Brownwood that at Abilene---about one-and-a-half times as much.
8. The water bill for a typical family, using ten to fifteen thousand gallons a month, would be almost twice as high in Abilene. It appears, therefore, that price is exerting an influence here which counteracts all other factors.

8. Type and Size of Industry

Except for possibly half a dozen industrial categories in which large quantities of water are used, I believe that industrial water can be included with all other uses in a single per capita figure---at least for large metropolitan centers. Care should be exercised in the investigation, preparatory to making a projection, to insure that the water usage from all sources is included in the total present use. The total may then be separated, or not, as judgment dictates, into municipal and industrial parts. The decision---for reasons previously stated---should not be based solely on whether particular water users are currently buying water from the municipal system.

Where the special large water using industries exist, their water demands are apt to be quite large, sometimes far overshadowing the municipal use.

9. Accuracy of Measurement

This is not, of course, a proper variable upon which it could be said that water use depends. It is included here because of personal conviction that inaccuracies in measuring, compiling, and publishing data constitute a major reason for difference in the reported use of water.

It is by no means obvious, to the management in many operating water companies, that it is necessary to account precisely for the total quantity of product delivered. A large part of the cost of rendering water service is made up of fixed capital and operating expenses, not directly related to the amount of water delivered. The front office is primarily interested in revenue, and many of our largest water utilities rely, like the telephone company, on a system of flat-rate monthly charges as the major source of this revenue.

The design engineer is concerned with ability of the system to meet peak rate demands. The pump station operator governs his plant output by the pulse of the distribution system as evidenced by strategic pressures or the height of water in elevated tanks.

It is apparent, then, that none of these people are vitally interested in the annual output of water. Only for long-range planning of source developments is this information indispensable.

The second major reason for inaccuracy is the difficulty of measuring the quantity of water dispatched from a pumping station. Since it flows continuously but unsteadily, it cannot be counted by discrete units, as can sacks of potatoes or carloads of coal.

Typical meters measure rate of flow indirectly by its relationship to some measurable pressure difference; the instantaneous rate is translated and integrated mechanically into total quantity. To be sure, these meters can be and are built to a high degree of precision---but maintenance by highly trained specialists is required for continued accuracy. Furthermore, they are expensive, and many small water systems do not have them.

Improvement in the completeness and accuracy of data may be expected to result from education in the importance of water accounting. The operator needs the motivation of knowing why he is doing the job and training to teach him how to do it.

The growing use of the techniques of mathematical statistics, facilitated by electronic computers, can greatly improve our understanding of the significance of masses of data. It is well to bear in mind, however, that no amount of statistical manipulation can compensate for gross inaccuracies in raw data---and that the electronic computing machine reproduces flawlessly any mistakes fed into it.

PROJECTION METHODS

Future water demand may be obtained by: (1) direct projection of annual quantity of water, from the amount used in a base year; (2) projection of population and an all-inclusive per capita use factor which, multiplied by this population, gives total water demand; or (3) projection of population as before and selection of appropriate multipliers to give separate components of water use. Each method has advantages, and each has been used, at one time or another, in the reports prepared by the Region VII staff.

The first method is the simplest, the most direct---and probably the most vulnerable to criticism. Implicit in its use is the assumption that population and water using activity will grow apace with the projected water demand. There should be, but isn't always, the additional implied assumption of the presence of the other factors which, in turn, cause population to grow. The water department of one of our major cities has the catchy slogan: "Podunk grows where water goes." Critics like myself would quibble that the slogan is worded backward; they mean: "Water goes where Podunk grows."

In my opinion, the second method is the preferred one of the group unless there is good reason to depart from it. The investigator would examine all of the evidence, weigh the evidence with regard to the parameters discussed in the preceding section, and render an opinion. That is, he would select for the target projection year a single per-capita number embodying municipal-and-industrial water, and multiply by the projected population. I would say that this method can be applied to large metropolitan centers in which there is not disproportionate activity of one of the special, large water using industries.

The third method is, or should be, a modification of the second. I would split off, for separate projection, whatever is special, unusual, or atypical at the particular place. All the rest of the water demands could still be incorporated into a per capita figure and called municipal. The projection technique for the special component would depend on its nature. For some industrial categories, the preferred approach might be to project total production and multiply by water use per unit of product. For others, the multiplier might be water use per employee. A third possibility is to make a direct assumption of percentage increase in quantity of water from analysis of the potential for growth in that industry as determined by the resources available to support it.

In selecting factors for projecting industrial use, every effort should be made to obtain local data. Unit water use within many industrial categories is so highly variable as to render virtually useless the national or regional average figures. The chemical industries present an especially knotty problem. We can do little more than guess at what the products of chemistry will be fifty years hence. (Incidentally, this writer deplores the inordinate fear of using that word, "guess"; the substitution of euphemisms seldom fools anyone.)

In contrast to industrial demand, it is confidently expected that municipal (population-oriented) water requirements will vary within rather narrow limits. I believe the time is approaching when we will be able to draw iso-per-capita lines on a map of Region VII and to use them for estimating municipal demand. This will require, first, rejection of incorrect data in the past record, and then adjustment for the influence of rainfall and standard of living.

We do not yet have firmly adopted numbers for placing such a map. I am convinced that they will be substantially higher than those given by the Public Health Service to the Senate Select Committee---particularly the figures of 114 and 106 gpcd for the Western Gulf (year 2000) published in Table 5 of Committee Print No. 7. I suggest, for the year 2010, a range from about 140 gpcd in the humid, to about 230 gpcd in the semi-arid, parts of Region VII. (We have not made detailed studies in the arid part, New Mexico and extreme West Texas.)

Finally, if it is concluded that the best we can do is define a range of values within which the answer lies, then the numbers should truly reflect a range. To speak of a "medium" value of 114 gpcd and a "high" of 106, is both contradictory in terminology and ridiculously narrow in latitude. If "that's the way the ball bounces" as the result of a whole series of judgment decisions made in arriving at answers, then the ball should be bounced again.

SUMMARY

Despite perplexing questions as to whose water it is, water is a natural resource which can be considered to respond - at least to a degree - to the same economic laws that govern other commodities.

Objective water resource planning can be substantially bereft of funereal aspects, and approached with confidence and optimism. We are not about to run out of drinking water in Region VII.

For the purpose of estimating future demands, water use should be subdivided into as many components as will improve the accuracy of the sum of its parts - and no more.

Certain methods of subdivision have been suggested, along with suggested methods of approach to the problem in different circumstances.

Examples have been cited to illustrate the influence, or the absence of influence, of parameters commonly considered to have significant effect on water demands.

Estimates of future water requirements should take into account both general trend and cyclical variation. A drouth frequency should be adopted as one of the basic premises of planning studies, and both supply and demand should be estimated for the climatic conditions of the design drouth.

Average per capita use of water will continue to rise in some areas as an increasing percentage of the population moves up to higher standards of living. On the other hand, it may decrease in other areas where metering and other conservation measures have not been practiced in the past. Suggested values for Region VII are 140 to 230 gpcd in the year 2010 - the range reflecting primarily the influence of rainfall under design drouth conditions. Adjustments should be made, as local investigation indicates, for the effects of such parameters as: availability and price of water; types of industry; and, perhaps, size of city.

The Public Health Service should review its position as established by the report to the Senate Select Committee, and make some revisions - particularly an upward revision of the figures in Tables 5 and 7 (Committee Print No. 7) for the Western Gulf and Ark-White-Red water resource regions. Our position is weakened when we cannot cite our own publications in support of conclusions.

DISCUSSION

Paul DeFalco
Project Director, Water Resources Section, Division of Water Supply and Pollution Control, Public Health Service, Regions I & II, Department of Health, Education, and Welfare, New York, New York

Actually his (Ownbey's) choice of method that he finally settled on - his method, his choice of using the sum-total of the water used for community and expanding on this with a reasonable increase factor it appears to be the most logical method to use under the circumstances at the present time. I must also agree that we lack a great deal of information in this area. It's an area where we haven't had a primary interest. We are first starting to develop it - it's an area where we need much research, much study. We have to determine the motivation behind water use. We have to determine why people use water, why they increase or decrease their use of water. At the same time, I'd like to speak on another point which Ray has touched on when he closed - this question of the Senate Select Committee document. I also happen to have a proxy from headquarters to answer some of the objections that have been raised on this point. I'm not speaking from my own experience here, but rather from the headquarters viewpoint. I would like to read a short section here - Mr. Ownbey seemed less than satisfied with what had been written in the Senate Select Committee document. He pointed out his personal experience in one of the two Texas cities, wherein their records showed consumption rates for domestic use particularly, considerably higher than we use for the Senate Select Committee. It is true. The rates for one or two of the cities in Texas according to the inventory were higher than the final figures we used, but not sufficiently so to bring that final figure up to where he seems to think it should be. There is another point that should be firmly kept in mind. When we are under great pressure to do something and to do it quickly, we use the available data to arrive at a national total, and do not anticipate that the regional or basin figures will be released for use in so specific a sense for which they are not really intended. However, administrative decisions reversed our position in this matter. That's the close of comments from headquarters. But at the same time a very interesting question is raised. We, in the regions, have to deal with the people. We have to deal with the problems. They are very unique problems, usually, in our areas. Headquarters, rather, has to deal with the sum-total of these things. They have to make simplifying assumptions at times. There is a need similar along the line here for reconciliation of these two viewpoints. There is no easy answer to this. When you're a thousand or two thousand miles away from the problem, it's very easy to rattle off a quick answer using rule of thumb. Sometimes that rule of thumb backfires. The last two days we've been talking about projections, forecasts, what-have-you. Up in our area we call them "guesstimates" - I think Father Flannery will probably object to that word, too - but they're the best we can do with our knowledge at the present time. We have much to learn in this field. We should go ahead with what we have now, do the best we can, but at the same time we should move forward. We should attempt to delineate some of these areas. We have research projects which we sponsor. This is part of the work that could be farmed out. They will be different for each area of the country, but maybe we might discover the link between these various things - the cause and effect relationship, so to speak. Without it, we have to use rather gross rules. At the same time I wonder whether we are trying to refine something beyond the need that we have. We design water resources structures on a hydrological basis. The inputs for water resources systems are highly variable, both in quantity and quality. They are never known with certainty, only with probability. In planning the knowledge of future hydrologic events we are usually limited by the limit of the past record. The only virtual certainty is that past history will never repeat itself. The same is true for the demand end of the business. The uncertainty in the demand side is considerably greater than the hydrological supply uncertainty. Some hydrological events are basically random. The range of variability to an extent can at least be defined. However, future demands for water and water-related products are not random, but rather dependent upon estimates of future population growth which have variabilities around them, industrial production - we know we don't even know where they're going - technological changes which we don't even hazard a guess at, uses of leisure time, and many other factors. The farther ahead demands are estimated, and the smaller the area for which estimates are made, the more uncertain these estimates become. The estimates, to quote Resources for the Future, - they say the range of error increases geometrically as the national economy is subdivided. Well, this puts us in quite a spot. We're down at the bottom of the totem pole. We've got to come up with the answers. And apropos of these answers, I'd like to raise a few questions for discussion: One, what is our part - the region's part - in formulating water use and water quality requirements? And where is headquarters' logical position? Is there a need for some guidelines and some acceptable national policy with the allowance for variation for local situations where properly justified. Is headquarters' purpose to provide direction as well as review? How important is conforming, nationwide, in the work of our division? Does its value outweigh some of our regional politics? I'd like to leave that for discussion, now.

GENERAL DISCUSSION

OWNBEY: With regard to the letter from headquarters, just to repeat what I said at the beginning, I'm not attacking any person or group, and I certainly wouldn't say that I could have done the job any better, if at all. With regard to this matter of time element, and insufficient time - sure, we all understand that. That's a perfectly good reason for having turned out this book in January 1960, but that was a year and a half ago. There has been considerable talk here about the desirability of standardizing on certain things. Jim Flannery brought up the desirability of having some uniformity in looking at the national picture. It would be nice if we could come to some sort of general agreement - some sort of ball park figure, as to what per capita figures to use for municipal demands, in different parts of the country. But if this one document which was put together hurriedly and turned out before the 1960 population census data were available, has now become headquarters' - what's the word for it? - "sacred cow"? - then, I'm not sure we can go very far towards standardization, if we're not willing to leave this standard format flexible enough to make corrections.

HAYWOOD: We of Region VII feel that per capita demand figures are going to continue to rise. Is this the concensus of all Regions? Are we speaking for the Public Health Service?

KLASHMAN: What do you mean?

THOMAN: I participated with Sted Green in some of this business on per capita water use and possible increases over the next fifty years prior to the time that the Senate Select Committee report was made, and neither he nor I frankly saw any basis in performance over the period 1939 to 1957 or 1958, that justified on a national basis of having any significant increases in per capita water consumption in the United States. Now, the facts are available for anybody that wants to dig into them, but it has been running in the neighborhood of a hundred and forty gallons per person per day on a national average basis since 1939, and we saw absolutely no reason, even with the increase in the automatic washing machines and garbage disposal and swimming pools and so forth, for a national figure going any higher. Now there are bound to be isolated incidents, and I expect you can cite some here in the Southwest, but over-all there was no basis for raising this too far.

DE FALCO: You were in headquarters; originally you were in a region. I've had this thrown at me by Ken Jenkins at times, being a regional man, and they say they can only give us an answer as good as the data we submit. And in reviewing some of the forms it is fairly obvious that the data we submitted hasn't been too good, - water use doesn't change over a ten-year period although we know population

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THOMAN: I don't thing the data are wrong, sir. Admittedly, the analysis of the data is no better than the information that's furnished in the field, that's true. But on a per capita basis - I'm not talking about total water use - I'm talking about per capita basis, it's been on the basis of 140 gallons per day from 1939 on through. There are some unpublished data which got lost and I couldn't find, - on the '48 or '49 inventory, I forget which one - it came out exactly as William McKenzie and Sam Weibel did on the original inventory. Very little differences showed up on the over-twenty-five-thousand water inventory in '55 - '56 - '58, and I don't know what the '57 over-hundred water inventory is going to show, but I'll bet there's not much significant difference in there.

HAYWOOD: I'm not saying we're right in Dallas. Our records show that there has been a steady rise. I'm not being critical of headquarters' philosophy, or the statement Jack just made that says since 1939, the figure has remained 140 gallons per capita per day on a national average, but I am in complete sympathy with Paul's point that the data that is supplied from the field leaves a great deal to be desired. And I'll cite the great State of Texas - I'll cite the Chief Engineer of the Texas Board of Water Engineers, who says that he'll give us figures on per capita use, but he will not vouch for their validity or their applicability. I talked with a man in the State Health Department who was criticizing the per capita figures that had been provided to us from his department, and he was criticizing the calibre of information that had been obtained. I said, "But that came to us from you." "Oh, no," he said, "we just sent out the questionnaires and mailed them to you as they came in." Well, we take these tabulated figures, population and water use, and run some per capita demands, and they vary all over the map. I think we've had one as low as 3 gallons per capita day, others as high as 300 to 400 gallons per capita per day. Something's got to be done, which brings me to my next point: I think that the only way we're ever going to come up with any realistic per capita figures is to conduct a shoe-leather study across the nation in all regions. And by that I mean simply this: We've got to put people out on the streets of municipalities, getting information and authenticating it, checking it - people with sufficient background in water treatment and water distribution to know when they come up with a per capita demand of 400 gallons per day from the records of a municipality, that there's something fishy. They've got to go in and find out what's fishy. I don't think we're going to get any realistic figures in anything short of that.

SCHEIDT: I don't know whether I want to make a comment or a confession, because I wrote that document and I will take on my shoulders any blame that needs to be placed for whatever's wrong with it. But

I'm a little bit appalled at the sanctity with which this document is being treated - so I would like to make a plea for viewing the document for what it was intended to be. We were asked by the Senate Select Committee in a very big hurry to give them what information we could on the probable future of municipal industrial water supply - they made their own estimates of self-supply of water, we didn't have to do anything about that. They gave us the specific cities for which they wanted the data, and they gave us a time within which they wanted it. This document was the result. We were quite aware when we wrote the document of the difficulties involved resulting from the revelations of pure statistics which were accumulated through the questionnaire-inventory system. The statistics were supplied to the headquarters office from the municipalities involved. You can't get around that. But we were also quite aware of the fact that a great many people around the country had varying views about the probable future course of per capita water consumption. And it was for this reason that we, following the tabulations, included textual discussions indicating factors which might influence in an upward direction future water supply consumption. And I would urge you, in viewing this document, take into account the text along with the tables. And secondly, that you do not use this document as a gospel. It was not intended as a gospel - it was intended as an indicative document revealing certain statistics and indicating certain probabilities with respect to what could happen, giving finally possible maximum - future possible maximum volume, consumptive volume. I don't think you should view it in anything more than this light, and I think that in each individual situation you are confronted with, you should then make independent studies and examinations. This document was never intended as a Bible, and I don't think you should view it in that way.

TORGET: I have just one comment: the gallon-per-capita-day is the result of two variables - the amount of water and the population. I might state this in regard to the one - the variable there, population - it would be interesting to know what the trend showed between '40 and '50, when the population was known, because the Sales Management Magazine, which goes to the water departments, among other places, to get their estimates of population have been notoriously high - almost uniformly high - on their population estimates, and the number of people served in the community. So to that extent, it would serve them to reduce the per capita consumption. When you're working with the figures, you have no alternative but to use the figures you get, but at least from that standpoint, it would have a tendency to decrease. Now that the '60 figures are up, it's going to be easier to compute for the years of '40, '50, and '60 - at least when that one variable is specifically known.

WITHEROW: I would like to point out that there is some additional information available on per capita water consumption which has been

been collected through an FHA-sponsored study in Cincinnati. Though this study is somewhat limited in its scope, it does cover some tendencies, and the data selected is very accurate in terms of quantity of water used and per capita use of that water. It does definitely show some indications of the influences of modern appliances we now have in homes we didn't have. It also shows tremendous range of views that one can get and some of the variables that influence this range. I think that this publication will be out at the end of the fiscal year. At least, that's the time it's due for release.

NASI: It's unfortunate FHA will come out with factual information based on PHS studies.

THOMAN: This reminds me of the ten cities - remends me of a rather eminent statistician that gave a talk to the American Society of Civil Engineers in Washington one time. He said he made a survey before he came in. He stopped three people on the street and he asked them a question. He said, "One said 'yes', one said 'no', and the other didn't have an opinion." So he said, "The thing is, 50 per cent of the people believe this way, and 50 per cent believe that way." With 10 cities I don't think you're going to prove a darn thing, especially when you're talking in the neighborhood of nine or ten thousand - seventeen thousand, I believe.

NASI: Bob did raise a question concerning the need for a shoe-leather study in the matter of per capita consumption of water, and Keith was out at the time.

SVORE: I did want to ask Keith that one question. Do you plan to come out with a subsequent report of some kind that will have different figures from what you had in the Senate Select Committee report? I should have asked Mel. I mean, this thing is thrown up in our face, as you know, in our local work.

KRAUSE: I'm beginning to conclude that it might be a good idea to clarify the purpose of this report. Almost weekly now we get some mail from here and yonder asking "Well, what does this mean? That doesn't apply to our city," and, "How could you write so and so?" I think perhaps we have a situation like this much the same way that many of your offices are faced with from time to time. We have a deadline to meet - you don't have time to consider everything, so you put in this, and do the best you can. That's what happened in connection with this particular group. It was never meant to be the last word, and we, of course, have been a little bit surprised to find that since it appears in here it has been accepted more or less as gospel truth, and cannot be departed from. I can only tell you a little bit about the hassling we did in connection with this when it was in the throes of preparation. Should we do it, or should we not? We did not have but a matter of hours to make the decision whether we should or shouldn't. It seemed that on the basis of pure statistics -

and yet I think that everybody who participated in this - at least the few in our shop - felt from personal experiences that there ought to be room for some deviation, and I'm sure this is what Mel explained to you a few moments ago. There are some qualifying statements in there which were put in there for the purpose of possibly meeting the needs - the local needs - that there must be some leeway, and knowing full well that what we're trying to do there was, anyway, approach a national figure in this matter, and probably Jim was in on those sessions also - it was apparent that the statistics were going pretty much in one direction and some of them in another direction. The only way we could get together on this was to write some words. We had to show the statistics and we had to write the qualifying words, and this is what we attempted to do. Perhaps some qualifying statements may be necessary. If it's done, and I'm not sure that I can speak for the Basic Data Group, - their feelings might be just as strong now as they were when this was written - but as I say about this, there's just a good possibility they're right. Don't ever underestimate this possibility, too. As I recall, many of the arguments to such things as changes in urban living from individual residential - residences to apartment dwelling - this has a very definite tendency as illustrated in a number of places in the nation, and is reducing the per capita consumption of water. Taking certain selected counties out of the nation where some of the highest per capita incomes exist, you find mediocre to low per capita water consumption. So, again, we get into a position of not generalizing. We're going to have to use these figures - you're going to have to make your own judgments as to whether or not this is going to suit the occasion with which you are being confronted. Who is to really say whether these figures are wrong or not? At least they'll give you the benefit of some national statistics. Now if you can justify departure, go to it. We're not going to hold you to these things, but if you depart from them, then have your arguments prepared. I think this is the thing - when you are confronted with papers, reports, and you find it difficult to justify your figures in face of the documents prepared by the Public Health Service, comparing, that you find it a little difficult, but you use the same argument that I'm using now - you have reason to believe that what you're doing, ordinarily, is the correct situation. Whether we express it here - remember you are forecasting your judgment, taking into account local conditions - I don't think there's any mechanical means by which you can sit down and project these things out. Just remember that when you do so, that you're taking into consideration something that may not have been indicated in the past. This is the best I can tell you at the moment. Whether or not we will actually attempt to clarify this in the future - we may somewhat in the same manner as I'm doing now. However, I surmise that the wide distribution of these reports and publications would make it virtually impossible, even if we did write some clarifying reports, and that's what they would be - I don't think it would be a retraction in any sense of the word. We will just accept it for what it is, and go on from there. But I would hope that you would understand that this is no way - as far as I'm concerned, these figures are a part with which to start, if you will.

NASI: This subject has received quite a bit of attention and has flushed out the men that wrote the report. I think perhaps, Bob, for your purpose the discussion has been adequate. I am sure that headquarters is going to follow up. As Keith said, he's not going to retract the report, but he may issue something to modify it in the future. The procedure here is to arrive at some summary of conclusions on the basis of this paper. Mr. Ownbey has read the summary on page 20 - is there any dissension on the part of any one here concerning the specific statements that he has made? There were some questions raised by the speakers concerning figure 1, for example, - does anyone want to comment on why the trend was downhill from 1920 to 1930 in terms of gallons per day per service connection in Oklahoma City and San Antonio? Mr. DeFalco raised some questions concerning the need for headquarter's guidelines and I think that's inherent in this other discussion, so we won't go further with that. Does anyone else have any question or comment at this time before we adjourn for coffee?

SCHEIDT: The last conclusion on page 20 is rather categorical. It says flatly,"Average per capita use of water will continue to rise as an increasing percentage of the population moves up to higher standards of living." I'm not sure that I would want to buy that exactly in that tone. I think in many places it will - I think there may be other places where it won't, and for that reason I would have some reservation of the absoluteness of the language. I think that this whole business of projecting water demands must be handled on an individual basis with each city under circumstances and conditions economic, social, climatic, and otherwise that are involved. This is indicated in other conclusions and I think with the other conclusions that one might well be left out, and let the projections ride on the merits of the findings in each case. They may well go up. I think myself that in many cases they will, but I wouldn't want to make that kind of absolute statement anyway.

OWNBEY: Would it overcome this objection if we put in - if we inserted the qualification "in the Region VII area"?

SCHEIDT: If this is a conclusion of the Region VII people, I wouldn't argue with that at all. I wouldn't try to.

OWNBEY: As far as I'm personally concerned, I haven't been nearly as much concerned with the question of whether it is going to rise in the future from the present - I did mention this, but in the particular case of Dallas, again, the figure stated in the report for the base year is wrong. It's too low. At the present time per capita use in Dallas and Fort Worth is about 140 gallons.

SCHEIDT: On this score let me suggest where it is necessary to get the figures in Region VII, I want to tell a little story, if I may, Mr. Chairman.

NASI: Make it short.

SCHEIDT: I get a little bit disturbed every now and then at the sanctity with which the field views things emanating from Washington, because things that are developed in Washington are written, are developed, are published, are designed by human beings that are guys no different from those in the field, and they should be viewed in that light. Some years ago I found myself Assistant National Director of a group that was attempting to develop some programs for municipal public works in anticipation of a post-war public works program that might be needed on a national basis. For that purpose we in Washington devised some manuals and some representative forms to be used in the several cities where our people would go to assist the cities in preparing comprehensive long-range programs of their works. We told the people in the field that the forms that were included in the manual were representative and suggested forms. We repeated time and time and time again that if those forms did not suit the city in which they were at the time working, they should be thrown in the wastebasket and they should devise their own forms. I went into the field time after time to assist, to give guidance, and I would tell the man in the field precisely what I've said to you, that a fellow in Washington named Mel Scheidt devised that form. It's a suggested form. If you don't like it, throw it in the wastebasket. And almost invariably after I got through with this admonition that they should use their own judgment, somebody in the back would say, "Mr. Scheidt, on this form you devised, question 13-A, thus and so, how should that be filled out?" By that time I was ready to tear my hair. You've got to use it for whatever good it is, and if it isn't suitable, throw it away. Use your own methods.

ROGERS: Down here at the bottom of page 20 you mention, and Paul also mentioned, a drouth frequency should be adopted. I just wondered if you had any suggestions along that line. I'd like to bring out just one point - we've run into this just recently. The Corps of Engineers asked us to come up with low flow requirements. In one of their projects the figure they always quote is the lowest one they have on record. This happens to be once in 50 years, and this seems to be the one they want to use. I just wonder if we shouldn't come up with some ideas along this line.

MUST WATER TREATMENT BE HIGH PRICED?

By

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ABSTRACT

Water treatment begins at the point of use, and the final treatment is provided at the point of discharge. Design criteria can become too stereotyped, resulting in more costly treatment practices. The waste stabilization pond is probably the most economical system of waste treatment for many of the smaller communities. However, as with all present-day treatment operations, much research and development is still needed.

Water is one of the necessities of life. Furthermore, it is one of the major resources in the United States. The distribution and use of water is controllable to some extent, but the reuse of water is dependent upon the resourcefulness of the present generation. The pollution of large amounts of water with smaller amounts of contaminants is an economic luxury which this nation cannot afford. It is recognized by most responsible people that the use of water is a privilege and that treatment of used water is a necessity. The degree of treatment may vary from place to place, but the cost of treatment represents a fee for using the water.

Merciless man must not turn the streams into poison for other users. Man must pay, but it need not be expensive.

If the majority of our future water supply is to be a mixture of pristine and adulterated waters, then water treatment must logically begin at the point of pollution and not at the water intake of some downstream user. This paper describes some of the reasons why domestic waste treatment need not necessarily be expensive. The ultimate objectives remain the same with regard to water treatment and use, i.e., it is not only desirable but necessary to destroy the pathogenic

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microorganisms and, in some manner, reduce the putrescible organic matter to carbon dioxide or otherwise inoffensive substances. The scientific aspects of the algal-bacterial commensalism (eating at the same table) system will be considered herein, but the emphasis will be placed on the development of the "art" of waste-water treatment by the use of waste stabilization ponds.

Engineering Apathy

Water quality control is an engineering problem but with roots in almost all the social and scientific disciplines. Engineers, as a professional group, pride themselves in being able to utilize these various disciplines to obtain one or more plausible solutions to an engineering problem. Once having developed possible answers, the professional engineer makes his decision on the basis of an economic evaluation. It is at this point in a water development study when an engineer searches his mind and conscience for all the knowledgeable facts. The figures are bared, and an honest appraisal is made. It is a rare case indeed when the engineer reaches a major decision on purely materialistic considerations.

Even as individuals, professional groups sometimes become engrossed in what are all too frequently described as technicalities. This is clearly demonstrated in the area of water and waste treatment. To this extent the American engineer has expended much effort on the use of power and extended the application of mechanical appurtenances, particularly in the field of water treatment. He has strived to perfect larger and more sophisticated systems. This, in itself, is not bad because the creation of things satisfies the innermost desires of most builders, and the engineer surely is a maker of things. For some engineers, dedicated to the field of water resources, there is the age-old desire and challenge to control the movement of water, to build large impoundments, and to construct impressive treatment facilities. All of these systems obviously are to be built on a river that has water of the highest purity and no historical connection with domestic or industrial use. Even if water has been used as a transporting medium for industrial and municipal wastes, it is still a challenge to design complicated systems satisfying the latest in experimental equipment. The temptation is great to erect mammoth air-compressor and air-dispersal systems which provide air in ever smaller bubbles, and to build biological treatment systems that are continually helping to reduce the mean flow through time. Such devices are economic necessities in some places but not in the majority of cases.

It is of considerable significance that through the centuries the definition of water purity has become more sophisticated. As the standard of living has increased, the criteria of purity have become more rigid and possibly more quantitative. In retrospect, the engineer as an individual may have become accustomed to recommending the "Park Avenue" variety of hardware and, in some ill-advised situations, completely ignoring the dictum that all plausible solutions to the water treatment problem must be considered before submitting a recommendation. A case in point is the small-town sewage treatment plant. In most cases the engineer knows full well that the operational control required of this "Park Avenue" treatment plant will not be forthcoming. As a matter of fact, in the past it has been difficult to obtain appropriate operating experience for the plants servicing the larger cities.

Has it been complete disregard for economic principles which has led the engineer to choose the sophisticated designs? The answer to this question is, "Probably not."

Historical Objectives

It has been customary for engineers to be content with developing more economical unit processes including primary sedimentation followed by aerobic biological treatment and the anaerobic digestion processes to stabilize the unoxidized solids.

The conventional treatment systems, for obvious economic reasons, have not been designed to recover significant amounts of nutrients in the waste water, these nutrients being primarily phosphorus and nitrogen compounds. The total nutrients in the near future may actually exceed ten million tons annually, and the next generation of engineers may very well be concerned with the problem of total nutrient recovery.

The historical treatment plant, for not always obvious reasons, has been designed to provide oxygen by mechanical means. The oxygen is utilized by bacterial masses in synthesizing more cells or oxidizing the organic matter for energy-conversion purposes. The mineralized effluent from such processes represents a considerable amount of fertilizer in the form of inorganic solids.

Unfortunately, it is at this stage in the historical treatment processes that the conventional system begins to break down. The putrescible material has been reduced to simple organic products, compounds of nitrogen, phosphorus, etc. It is not desirable to have this fertilizer in the water because in the presence of sunlight these nutrients will support a crop of microscopic plants. Yet this is exactly what happens. The low-energy materials which have been added to a stream as a result of domestic and industrial wastes are converted to high-energy forms through the process of photosynthesis. The aquatic flora in itself is not so seriously objectionable, but, in terms of hydraulic terminology, steady state conditions of growth are difficult to maintain. Sunlight, temperature, food, pH, and numerous other factors influence the harvest. The stream, after receiving the expensive and highly treated effluent, is subjected to a cyclic form of crop rotation. This is likely to be a particularly difficult problem in the future.

The tremendous fluctuations in algal blooms have not been experienced in all sections of the country because the deposits in stream beds have been periodically flushed out to the ocean, but, as the streams are more rigorously controlled by the construction of impoundments, this periodic flushing will not take place as often. This mode of water-resource control will tend to place new pressures on the engineer to examine the manner in which water and waste-water is usually treated.

A reservoir which receives a continuous steady supply of nutrients from an upstream source can eliminate these nutrients either through discharge via downstream releases or through the transfer of these nutrients to higher forms of life such as fish. If the fish are then removed, this represents a net loss to the lake. However, it must be pointed out that the base level of nutrients in a reservoir at any time in the future, regardless of whether the reservoir has been nearly emptied and then refilled with dilution water, will be greater than the initial base level. Also, the higher trophic levels, as represented by fish, are not considered to be primary consumers of nutrient as are the bacterial and algal systems.

The Ultimate in Waste Treatment

The most efficient use of the carbon, nitrogen, and phosphorus in conjunction with sunlight would be to convert these materials into usable food stuff or to put the water and nutrient on irrigable land. This approach is not new since it has been considered in Germany and in several investigations in this country. The scheme simply indicates that putrescible organic material and other materials, theoretically at least, can be transformed into a high-energy protein substance. By using algal-bacterial processes, it is possible to produce an amount of protein from one acre of domestic waste-water stabilization ponds equivalent to as much as fifty acres of irrigated cropland. The algae provide the oxygen for aerobic bacterial synthesis and oxidation. To complete the cycle, the algae utilize the carbon dioxide released by bacteria and obtain other trace nutrients to propagate their own species. The difficulty in this approach is the fact that the algal cells are very small, and they are difficult to remove from the liquid substrate.

Therefore, until it is possible to remove the algae and nutrient or the nutrient alone, the waste-water might as well be treated as economically as possible. Nutrient releases under present conditions will be about the same, and algae in the effluent from a waste-water treatment plant merely moves the algal system upstream a few miles.

Waste Stabilization Ponds

Sewage oxidation ponds are not new. Sewage lagoons and oxidation ponds have been used in Texas for at least 40 years. Prior to this time the Germans and the Chinese used a form of waste stabilization ponds or sewage lagoons for treating waste and raising fish. Waste stabilization ponds is a term, for lack of a better definition, which describes a more recent engineering development of the earlier sewage lagoons.

Today most nations, and states in the United States utilize waste stabilization ponds as a means of treating domestic effluents. It is estimated that there are over 2,000 acres of pond surface in Texas and over 400 cells. Most of these are a secondary form of treatment. However, it has been reported that there are now more than 300 communities in the Missouri Basin which use stabilization ponds as the sole mode of treatment.[3] Waste stabilization ponds comprise over 10 per cent of the secondary type sewage treatment plants in the U. S.[5] and compare very favorably with trickling filters and activated sludge treatment methods. As shown in Table 1, the conventional biological systems on an economic basis cannot compare favorably with waste stabilization ponds when the population contributing to the treatment plant is relatively small. Even when a population concentration of 100,000 exists, the per capita costs are still much cheaper for the construction of stabilization ponds.

Table 1. Per Capita Cost of Construction in 1913 Dollars for Treatment Plants in U. S. (a)

Population	Stabilization Ponds	Trickling (c) Filters	Trickling (b) Filters	Activated Sludge
100	3.05	27.24	17.19	16.00
1,000	1.69	8.57	9.02	8.80
10,000	0.94	2.70	4.73	5.00
100,000	0.52	0.85	2.48	2.70

(a) Data only relates contract cost, or about 80% of total first cost.
(b) U. S. Total.
(c) Without separate sludge digestion.

The operation and maintenance costs of a waste stabilization pond are so much lower than those which would be required for the trickling filter and activated sludge treatment systems that there is no justifiable comparison. Table 2 shows the estimated annual operation and maintenance cost for about 300 treatment plants.[5]

The annual operation and maintenance costs for the primary plants are roughly equal to the trickling filter. These costs are roughly $1.40 per capita per year.

If it is assumed that the excess activated sludge stabilization pond in Austin, Texas, can be prepared on an equal basis, the operation and maintenance costs are 25 cents per capita per year. At present the ponds are receiving the BOD from equivalent population of 50,000 people.

Table 2. Estimated Annual Operation and Maintenance Cost

Expected Annual Cost ($/cap.)				
Population	Primary Plants	Activated Sludge	Standard Rate Trickling Filter	High Rate Trickling Filter
100	----	9.20	----	----
1,000	2.67	3.51	3.52	4.57
10,000	1.41	1.88	1.31	1.36
100,000	0.91	1.21	0.75	0.73

Furthermore, it should be recalled that these stabilization ponds could very readily handle twice the present load. The estimated annual operation and maintenance costs for the activated sludge and trickling filter plants are at least 5 to 6 times the cost of keeping a pond system. It also should be pointed out that a great deal of dilution water must be pumped from the river and mixed with the excess activated sludge at the Austin plant. This is considered part of the operational costs in this particular plant and would not be a major factor in the normal waste stabilization pond system.

Sludge Stabilization Ponds

In 1954, the City of Austin, Texas, found itself in a typical sewage treatment predicament. The inadequate conventional activated sludge treatment plant was converted and expanded to the Biosorption process at a cost of $390,000.00. The plant provided continuous good results for the first time, but while the new process solved the operational problem for maintaining a satisfactory BOD in the effluent and the immediate loading of the main plant, it did not solve the excess sludge disposal problem.[7] It was estimated that the capital cost of the digesters of adequate size for the 1954 load would be $750,000. The importance of this figure was that it did not include the cost of additional drying beds or a vacuum filter plant installation, nor provisions for future increases in load. Assuming there is a market in Austin for filtered and heat-dried sludge as fertilizer, which there probably isn't, there would still be a net loss of $8.00 to $15.00 per ton of sludge processed. The City of Houston reportedly sells their sludge for an average of $13.00 per ton but it costs them $21.00 per ton to vacuum filter it and process it for sale.

The decision was made at Austin to try the ponding system used by San Antonio for handling the excess solids. At San Antonio, Mitchell Lake with a surface area of about 700 acres has been receiving some digester supernatant, primary treated sewage and excess activated sludge for a long time. After considerable study, a 270-acre tract of land was purchased as a site for the sludge oxidation lake system. It is about two miles from the treatment plant and adjoins the Colorado River.

To date, three lake systems have been designed, constructed and put into operation. The capacities are 41, 65, and 85 acres.

The capital and operating costs are as follows:

Land	$120,000.00
Construction (complete)	455,000.00
Total Capital Costs	$575,000.00
Operational Costs	$ 12,500.00/yr.

It is estimated that the operating costs during 1958 when the ponds were not even loaded to capacity was $4.80 per ton on a dry weight basis. This represents a substantial saving as compared to other types of treatment. Also, at this time there appears to be a fair market for the bait and larger forage fish which appear to thrive in the lakes.

There have been no serious problems in the operation. Embankments were graveled to prevent erosion, and a gasoline driven paddle wheel was mounted on a raft to disperse floating algal masses which sometimes accumulate in a corner as a result of wind action.

The following is an abstract of the 1960 Annual Report of the Sewage Treatment Plant, Austin, Texas, describing the ponds:

5-day BOD Total Pounds	3,818,505
Pounds per acre per day, Average	55
Pounds per acre per day, Maximum	165
Pounds per acre per day, Minimum	0
Suspended Solids, Total Pounds	5,292,549
Pounds per acre per day, Average	76
Total Flow into Lakes (M.G.)	
1. Excess Activated Sludge	100.7
2. Digester Overflow	4.9
3. River Water	4,483.7
Total Flow Out (M.G.) Estimated	2,877.3
5-Day BOD in Effluent (ppm) Average	17.2
5-Day BOD in Effluent (ppm) Maximum	42.0
5-Day BOD in Effluent (ppm) Minimum	1.2

It should be noted that the first lake (41 acres) received an average loading of 200 pounds of BOD per acre per day which represented 90% or more of the excess sludge production in 1958. This loading might cause some concern, but, by the addition of the new 85-acre and 65-acre lakes, there is sufficient lake capacity to dispose of twice the present sludge production.

A Ransom for Nutrients

One of the biggest problems in water quality control is that of excessive nutrients in the water. Domestic wastes add a considerable amount of phosphorus and nitrogen to the water. As a matter of fact, domestic sewage is a rich source of the nutrients generally required by phytoplankton. However, it is noteworthy to mention that domestic sewage does not really provide a balanced diet for microorganisms. There is an overabundance of phosphorus as compared to both carbon and nitrogen. The organic carbon is usually limited in the case of activated sludge. Generally, carbon is not limiting in the case of algae because adequate amounts of carbon are normally available in the form of alkalinity.

As a matter of interest, normal phosphorus removal in a sewage treatment plant ranges from 2% for primary treatment to an average of 23% for the plants employing biological treatment.[4]

The possibility of removing nutrients, particularly phosphorus, by select species of algae is also realistic. The work of Bogan and others have shown that it is possible to remove nearly all the phosphates very rapidly by algal cultures.[1] It was shown in this work that the phosphate concentration could be reduced from 20 or more mg/l to less than 5 mg/l in less than four hours. The algae were responsible in absorbing or aiding the coagulation of the phosphates where removal of large amounts of phosphates were involved. However, common metabolic conversion is the principal mechanism of removal when a typical waste stabilization pond is employed.

The algae in phosphorus removal operations serve two purposes. In one case, an abundance of cell production will naturally accumulate a greater amount of phosphorus. In the second case, the phosphate removal is dependent upon a high pH, and, if adequate lighting is available for an abundance of algal production, the pH is increased. This latter requirement creates somewhat of a paradox in actual waste stabilization pond operation because the light intensity in the deeper pond is not generally adequate for the production of maximum numbers of cells nor maximum pH maintenance. When the day comes that algae might be utilized for both waste treatment and phosphate recovery, a totally different design will be needed. This day may not be in the too far distant future. At the present, a choice must be made whether to remove the phosphorus by maximum algal production or to maintain only a sufficient algal population to provide adequate amounts of oxygen for the bacterial population. Fish are a less efficient means of nutrient removal but possibly adequate to serve the present needs. A source of revenue might also be found in fish for cat food, feed supplement, etc.

Simplicity of Design

Waste stabilization ponds are economical because ponds may be designed to provide treatment of any wastes that can be oxidized biologically. The engineer must always remember, however, that the water to be treated has been contaminated and will be esthetically unacceptable to the general public.

It is desirable that some form of pre-treatment of the waste be the rule rather than the exception. Screening, in general, and preferably grinding should be provided for domestic waste to remove unsightly floating material. This type pre-treatment is also necessary for most industrial wastes.

Sufficient acreage should be obtained to prevent encroachment by residential subdivisions. If isolation cannot be obtained, additional volume should be added to the ponds, or sedimentation as a pre-treatment should be provided.

Ponds with sufficient storage usually exhibit an exceptionally high degree of coliform removal. In this respect, waste stabilization ponds may be used for providing a higher degree of treatment in combination with other types of treatment.

The principal factors affecting the design of stabilization ponds are light, temperature, waste characteristics, degree of isolation, and topographical features. If BOD reduction is the primary objective, it is not necessary to have maximum penetration of light. It is possible for anaerobic decomposition to take place in certain sections of the pond, namely at deeper levels, but this has no adverse effect on the overall performance as long as aerobic conditions prevail over the surface. In most cases, the oxidation reduction potential at the depths where there is no apparent dissolved oxygen will indicate an aerobic-type environment rather than a true anaerobic system. Temperature appears to be of considerable importance. Since the rate of biochemical oxidation is largely a function of the bacterial activity, pond requirements must be based on winter loading rates. However, excessively high temperatures during the summer may either produce an odor problem or an overproduction of algae. There have been cases where the water temperatures have increased in very shallow ponds to the point where the algal population was severely restricted and anaerobic bacterial systems created a considerable odor problem. This situation can be remedied generally by maintaining a somewhat deeper pond level, five feet or more. This increase in depth during the summer represents a basic change in pond philosophy. This will permit higher summer loading rates and the pond temperature will be roughly the same as the mean annual temperature. Since surface aeration alone will probably not provide more than twelve to sixteen pounds of oxygen per acre per day, the algae must provide the remaining oxygen.

If color in the effluent is a problem, series operation is a necessity. A lower algae concentration and generally higher quality effluent will result from ponds constructed in series. If the first pond is receiving raw sewage, it should be larger than the remaining ponds or septic conditions will prevail. Although the shape of the ponds is usually determined by topography, it is necessary to eliminate all stagnant corners. All the dikes should be well constructed. The top of the dike should be wide enough for automobile traffic. Gravel placed on the inner slope has proven to be very effective where wave action presents a problem. Other more permanent forms of lining probably reduce maintenance but greatly increase the cost of the installation.

Multiple inlets and outlets in the first pond are highly desirable. In this connection, it is important to have the bottom of the pond cleared of brush and other material before filling.

Every precaution should be taken in the design to prevent the possible breeding of mosquitoes, collection of floating algal masses, stagnant areas, and pollution of ground water through porous formations. Bank control will help eliminate the mosquito problem. Agitation of stagnant areas will prevent scum formation. Finally, bentonite is frequently helpful in sealing the bottom of the ponds.

The Economic Balance

The measure commonly employed in totaling waste-water treatment is "BOD removal" from a municipal or an industrial source. This is not an ideal measure, since other yardsticks (color and nutrient, for example) may still prevent the use of water for other downstream purposes. In water deficient areas, the color problem has not usually been considered a serious threat to quality. However, the immediate removal of readily putrescible material and the destruction of enteric organisms is of considerable importance in all areas of the country. Where there are a limited number of dollars available, the climatic conditions are favorable, and the geographical conditions permit, the engineer in all sincerity must consider the possibility of designing and using waste stabilization ponds. Except where land costs are excessively high and where population densities are much greater than are normally experienced in most sections of the United States, waste stabilization ponds are the least expensive of all the presently known forms of domestic waste treatment.

There are many problems which the engineer faces in the treatment of waste waters. As in all waste-treatment systems, the waste stabilization pond is not now nor should it be the ultimate answer for treating municipal and industrial wastes. At least twenty years of intensive research and development is required to answer problems which arise in the field.

Conclusions

1. Waste stabilization ponds may be designed and operated economically under a wide variety of conditions.
2. If necessary, a waste stabilization pond may be designed to accomplish all of the functions normally provided by partial and complete sewage treatment plants.
3. In addition to a nominal amount of light, temperature is the most important factor. Excessively high temperatures and shallow depths can produce nuisance problems as well as low temperature operations.
4. Although waste stabilization ponds are the least expensive means of treating domestic waste today, the following research and development suggestions and questions are submitted.
    a. Field studies should be made to determine the effectiveness of mechanical aerators in the first of a series of stabilization ponds. Certain efficient low-lift pumps and cavitators may help to develop an extremely active biological floc and thereby assist decomposition of the putrescible waste.
    b. The effectiveness of fish farming as a means of nutrient removal should be more thoroughly investigated.
    c. Additional algal and nutrient removal schemes should be investigated.
    d. Specific information is needed to determine the role of oxidation-reduction potentials in biologically active systems throughout the waste stabilization ponds.
    e. Considering various temperatures, what portion of the biochemical oxygen demand of an organic waste is satisfied by photosynthetic oxygenation? What fractions of the BOD are satisfied by oxygen from chemical sources and from the atmosphere?
    f. What is the effect of temperature as the sole variable on waste stabilization ponds?
    g. Fundamental studies should yield considerable information regarding the cycling effect of algal cell production and variation in species that is so obvious but difficult to explain.
    h. It is desirable to know the relationships between the pond and ambient temperatures as they affect the growth characteristics of the algae.
    i. What is the effective storage capacity of the bottom sediments as regards nitrogen and phosphorus?

j. Is there a health problem associated with the use of waste stabilization ponds for raising bait and forage fish?
k. In the larger lakes, what health significance might be associated with the use of these ponds as a duck and other wild life refuge?

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DISCUSSION

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Professor Gloyna has given us some good philosophy and a lot of good information as we would expect. I think he indicated that use of water is basically a privilege and that treatment of the waste is a necessity. I think he indicated clearly that mistreatment of water is a luxury that we can't afford. He pointed out that the cost of treatment is a fee for use - at least, it's part of the fee for use. He also pointed out that treatment must be at the point of discharge, and that the purpose is to prevent the discharge of materials which will interfere with the use of water - waters which receive the waste. He very clearly points out why treatment of domestic waste need not be expensive, and I appreciated his pointing out the tendency which most of us have seen - some designs apparently having as an objective the erection of a monument to the designer, and I know that all of us have seem gold plating in design that we wonder what we should say about, or how much we should say about it. Incidentally, the Missouri Water Pollution Commission has instructed its staff to evaluate the economics of waste treatment, and to question, or ask for justification of apparent gold plating in waste treatment design. I might say that this has led to the installation of quite a few of these waste stabilization problems in Missouri, and of course, throughout the country, especially in the Missouri Basin. Professor Gloyna has a very good discussion of the effect of nutrients on receiving waters, and some of the objectives in excluding nutrients. As a reference to conventional treatment in his paper - and I think the time might be here when we should use this with caution. The emphasis on the importance of consideration of nutrients in waste treatment - this emphasis reminds me of an incident, or a condition, that developed in Lake Washington in Seattle. Many of you are familiar with this - in fact, I see one here who lives on the shores of Lake Washington. This is in the middle of the Seattle metropolitan area, and is built up around the Lake - it's a famous recreation spot, source of water supply and waters for receiving waste. For years the Washington State agencies were insisting that the subdivision and the people around the Lake must treat their waste before discharging them into the Lake. Well, this has led to quite a problem. Now they're trying to find ways to keep these treated wastes out of the Lake. They are using some lagoons without definitely going to the Lake, and I understand that probably by now there is an interceptor at least under construction to carry the waste to the Sound instead of to the Lake.

Professor Gloyna points out that a lagoon and oxidation ponds have been used in Texas for over 40 years, and this is an area in which a lot of the basic work on this method of treatment has been carried out. Waste stabilization ponds, per se, as most of us think about it, at least those of us in the Missouri Basin, really had their start in North Dakota in 1948. This was the first such waste treatment device that was deliberately designed and engineered for treatment of raw waste. Since that time, of course, the method has been under study - Public Health Service has been studying lagoons since I think about 1949 - there are names on these studies such as Svore, Carl, Smith, Neil, Hopkins, and Towne, just to mention a few. Most of these men have made field observations and have studied the application of this method of treatment in the field.

On the other hand we have such names as Gloyna, Herman, Oswald, and Gotaas, who have studied the theory of treatment as well as having made observations of field application. These are basic studies which are very important. Many of these have been supported by Public Health Service financing. I want to just mention briefly some of the accomplishments in this field of the Missouri Basin. We can estimate that we are now approaching some 1,000 waste stabilization lagoon installations in the Missouri Basin. This is a method of treatment that is spreading rapidly to other countries. The Canadians are using it more all the time. Very often there are indications that there are some important problems connected with the use of waste stabilization ponds in the way of isolation. Actually, in our region now, we feel that a waste stabilization pond need be placed no farther from a residence or municipality than any other type of treatment plant. As far as a properly designed waste stabilization pond is concerned, it is not a serious problem - the mosquito problem is not serious. In fact, there is no problem if the lagoon is properly designed and maintained. These are factors that are taken into consideration in its design. All of you, I am sure, are familiar with the symposium that we had in Kansas City last August, and I presume that each of you has a copy of the proceedings. If there are any who don't, if you'll let us know if the Regional Office can't supply you, we will try to supply from the limited number of copies that we still have in our office. I understand the proceedings are being reprinted. What distribution will be made of those copies I don't know, but - is that right, Keith, the proceedings are being reprinted at headquarters?

KRAUSE: I do not know for certain that they are. I rather suspect that the demand has already required that they will be if they have not been.

CLARE: I'm sure that that is right, because we have had a request from Helman's shop recently for cuts and plates that were used in this printing, so I think the plan is in the mill. And as you say, this is the best seller that has been published and the present supply will be exhausted soon.

I don't think I'll take any more time. I call your attention to the fact that in the proceedings is a copy of the criteria for design, maintenance, and operation of waste stabilization ponds as prepared by the Missouri Basin Engineering Health Council - the State sanitary engineers of the Kansas-Missouri Basin States. Also there's a paper entitled "Design, Operation and Maintenance of Stabilization Ponds" by Wally Towne presented at the ASCE Convention in Phoenix last April, and this, I understand, has been submitted for publication and will probably appear in the ASCE Journal. I hope that reprints of this will be available.

GENERAL DISCUSSION

HAYWOOD: I'd like to make one correction. My request to him (Gloyna) was not to answer the question "Why Must Waste Treatment Be Expensive?", but simply, "Must Waste Treatment Be Expensive?" We felt strongly, and I'm happy to say that his talk and the following discussion substantially revealed that it does not need to be expensive. We feel in Region VII that we need some more information before we can feel safe and feel sure that it will do the job that can be done by dilution, and we are taking steps, we hope, to gain that information.

I'd like to ask Ernie a question; namely, what do you have in mind when you say, "The money saved will be put into other systems - tertiary systems and other forms of treatment"?

GLOYNA: To answer your question, what type of tertiary treatment did I have in mind - well, number one, I think that we can probably do a pretty fair job for the immediate future by expanding our nutrient operation in place. We can accumulate considerable amount of nutrient material in the pond system if we go to a series type of pond system, and then pull out of this system considerable amount of the forage fish that we will raise. This is one way, and possibly we may be able to knock down some of the algal systems early in the game. As all of you know, this at the present time is not too promising because these little plants are very difficult indeed to separate, but we do have considerable hopes of removing the algae. Down the road - I'm talking now about some of the plants that may be in the larger municipalities. I think possibly we can take a combination sewage-water treatment plant approach. Perhaps we can put a low-cost aeration system such as the one that is now being studied to some extent in Kansas - one which we will have in operation this fall in Austin, and take off some of the BOD load, then go into a short lagoon operation and where we know this water is going to be used again very shortly, perhaps we can take out some of the nutrients right then and there - some of the phosphorus. At the same time take out some of the detergents - take out some of the organics and other materials that are undesirable. Now for those of you that are coming from other sections of the country who may think of this as pretty far-fetched thinking, we are not in the Delaware Basin, we are in the Southwest. We are going to have people and we are going to have industry, and we only have "X" amount of water. This water can be made re-usable. We are not going to drink sewage, either, but a certain amount of this water that we're going to have down here will come from return flows. There is no question about it. We are already doing this to some extent, and we're going to do it a great deal more. So I think for the immediate future we can possibly do a pretty good job and one we should. With the algal system - higher forms of animal life - far down the road I think we may have to go to taking part of the water treatment plant and putting it back where it really ought to go

KLASHMAN: Would you mind telling us a little bit more about what you had in mind for removing the nutrients? We do have this problem - we're very much concerned about it. I'm talking about cutting down on your phosphorus and such.

GLOYNA: At the present time or down the road?

KLASHMAN: Both.

GLOYNA: Well, we think we can knock the phosphorus content down by adding additional sections to our lagoon. I want to qualify this a little bit, because if you look at the ecology of the system you must maintain a balance, and obviously what goes in someday has to come out, or you have to set it down at the bottom. As everybody knows, you don't accumulate a tremendous amount of sediment down at the bottom of a lagoon. But we can pull out a considerable amount of phosphorus, nitrogens, via the forage fish route, and we can also put a lot of the nutrients in the bottom - bottom mud. This is not going to be the total answer, but I think it's going to be a sufficient answer to help us for the foreseeable future. Now the reason I say this, is that we have done some experimental work along these lines. The work has not been published, nor is it complete - where we have operated on a pilot plant basis the ponds, and tried to make a material balance of the phosphorus - that which went in, that which left the system, and that which was retained, - and some pretty good experimental evidence there that there was quite a bit of material on the bottom. Now we can maybe have an alternate system where we can dredge out these phosphates and use them someplace else. The fish route now is the best.

PAHREN: From your experience, what types of industries use stabilization ponds in the Southwest?

GLOYNA: Well, these vary from lagoons to a designed system. Here in the Southwest we have one major petrochemical plant that is using this system to handle quite a number of waste streams. These range the whole gamut of the organic, including a lot of ketones and alcohol and what-have-you - some color compounds - this is a very large installation. There is another plant that has not been built as yet, but we will probably use lagoons to handle this waste. This will be the largest plant of its kind in the world. It will be down on the Gulf coast. Some of our paper plants have used a form thereof - not all as satisfactorily. We have one oil refinery that is using a form of this type of treatment.

SVORE: I just wanted to ask Ernie another question. Speaking of a tertiary lagoon following a regular sewage treatment plant - as far as the nutrients treatment and so forth is concerned, do you have any reason to expect that that should work any better than a tertiary lagoon preceded by a primary and secondary lagoon with proper loadings?

GLOYNA: Well, we don't have any data on that. We know roughly how much phosphorus or nitrogen will flow out of a regular trickling filter operation or activated sludge operations. We have some idea as to what we're doing in the lagoon operation. I think - I don't know, I'll have to pass on that - but I think we probably do the same in both cases.

SMOUSE: It seems to me we have considerable room for using our engineering imagination and ingenuity in this regard. It strikes me that it may be feasible in a good many cases to discharge our waste into ponds and then judiciously use this waste from these ponds for uses that it would be suitable for without having it ever reach our other waters.

GLOYNA: I guess I can't answer that directly. Let me give a case history of an industrial plant that I happen to know of now. The plant is a fairly large one - it has not made too much effort to cut down its water supply because this would reflect in its effluent - but there is every reason to believe that with the establishment of a lagoon we can put this water right back into the process stream and re-use it at the plant site - in this case we have a pretty high BOD and a very toxic waste. I think this is one of the things that we will see happen in this section of the country more and more. We have some power plants that are applying water from this operation now.

KLASHMAN: This has nothing to do with lagoons - the subject of this paper was "Must Water Treatment Be High Priced?" As we all know, in the Federal Water Pollution Control Act, Section 6-C, there's a statement that says the public interest must be considered. We're not doing this. If we have a state like Missouri that gives some consideration we are doing something - we all know there's a great deal of gold plating going on in these treatment plants - the beautiful brick basin, fancy fixtures, et cetera, and I would urge that the Public Health Service - that our division would do well to make a study of this subject to determine in some representative plants, just what portion or percentage is going into gold plating. We've noticed in our region, for example, in some areas where they've done away with a lot of this stuff that the costs of the plants have been very reasonable, but some of the consulting engineers have absolutely refused to get away from their original design. I think we should do something about it.

NASI: Would someone like to comment on Lester's suggestion? Keith, you're the headquarters man.

KRAUSE: I don't have any comment on it. It may very well be something that should be seriously considered. Economics are always something that should not be left to chance, and I cannot speak right now of anything serious to be taken up - the ramifications are obviously large. On the other hand, I wouldn't say that it should be done.

I couldn't comment, really, satisfactorily at this moment.

POSTON: I'm wondering how much Les might have been influenced in this question by the Regional Medical Director. I know that at one time we had a project in Michigan and we got a lot of noise relative to this because there was so much money being spent for a nice looking plant. And I know our comparison at that time had to do with a man that gets an appendix removed - he goes to the hospital and usually wants a good doctor. Some of them can't afford quite such a good doctor, and I think you may get your appendix removed - or any other job done - and pay a variety of prices. That also could go with sewage treatment plant. You'll find one town that will pay extra to have a nice looking plant, and they'll be proud of it, and the next town, well, they'll have a plant that just has the bare necessities, and sometimes they will maintain them in about the same manner.

SMOUSE: I think we shouldn't neglect to look at the other side of this coin. Wally touched on it very slightly there. I have seen towns build a sewage treatment plant and give their garden club $2,000 to beautify it, and you couldn't get through that town without going out to visit that plant. Now this has a certain benefit because it does sell taking care of your waste. The other thing that I think of - and this can be quite important in some communities - you put $100,000 into a small community and you create a great deal more than a $100,000 worth of business, and the extra cost may be returned several times. Your sewage plant may really cost them virtually nothing - so, we may be talking about something that isn't what is seems on the surface.

KEHR: I would like to add this to the discussion. I'm speaking now as a former employee of the Missouri State Division of Health. We actually encouraged the municipalities to doll up their plants - to spend extra money so that they would get a good looking plant - one which the city could be proud of. One thing that we had in mind was this: We were constantly striving to get improved operation. To get improved operation, to lifting the status of the sewage plant operator. If he has nothing but a small plant that is an eyesore to operate, it's very difficult to convince the community that this man is an important part of community life and that he is worth more money. And from this viewpoint, we felt that the added cost was well worth it. And I think, that if you'll take a look at this from the viewpoint of the State, you'll see that those agencies that are responsible for the continued operation and maintenance of these plants, particularly where you have what used to be a conventional sewage plant, you'll find this is a rather important aspect in endeavoring to raise the quality of the sewage plant operation.

GLOYNA: Gentlemen, when these proceedings finally come out, I certainly don't want to be put in the position of saying that I am not in favor of an A-plus, 100% job. I am. I want all of the things that should be in a waste water treatment system. I know that we have lagoons here in Texas that stink. We also have Imhoff tanks that are filled with grit. We have trickling filter plants that do not operate. In some cases they don't even have the valve turned in the right direction. We have lagoons - as in Austin, for example - that are well fenced. The fences are painted, the pump stations, lift stations, and the gatehouses are well painted. The slopes on the embankments are graveled so that there is no erosion. It is well-mowed and it is a beautiful sight to behold.

CLARE: I think we're talking about two different things. I think Ernie summed up very well, and I must agree with what he has in his paper and what he just said. What I meant to bring out, as far as my reference to Missouri was concerned, was the staff of the Missouri Water Pollution Commission's evaluation of the economics of the method of treatment proposed. For example, suppose an engineer proposes the installation of the secondary treatment plant for the small town in Missouri. Well, if the Commission itself has reason to think that he may not have considered which in its opinion would be cheaper, and cost the city less, in the way of first installation costs and for operation and maintenance, then it asks the engineer for more information. And some of these inquiries have resulted in a change of design. This is particularly true for military installations, where a few years ago there was an arbitrary reluctance on the part of the military to install lagoons. And the Missouri Division of Health was convinced that this was the logical method of treatment. And in those cases they were rather insistent that we give them more consideration. So I don't think we're talking about whether or not we should build an adequate plant - I think we're just saying that the different methods of treatment should be considered and evaluated.

MUST STREAM QUALITY BE MAINTAINED?

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My first reaction to the question which is the subject of this discussion was that I could dispose of it in short order with a simple, unequivocal "Yes."

On second thought, however, faint doubts started to arise regarding the adequacy of such a simple, straightforward answer. When I considered means of resolving those first faint doubts not only did they refuse to vanish but they actually grew bigger and stronger and in turn produced a brood of lusty offspring. Finally I was faced with such an array of clamoring doubts that I was driven to the reluctant conclusion that here was a question that required strenuous mental effort. After undergoing the necessary, even though distasteful, mental effort I have come, with mixed emotions, to the inevitable conclusion that here is a question that I, alone, cannot answer. The mixed emotions include both amazement and relief. The amazement derives from the realization that, despite some thirty years in this business of stream sanitation, I cannot glibly answer all the questions involved in arriving at a sound decision regarding the need for maintaining water quality. The relief stems from the realization that I, alone, do not have to assume the awesome responsibility for the ultimate decision.

As a matter of fact, neither this group, as well informed and competent as you are, nor the Public Health Service, with its weighty responsibilities in the field, can make this decision. It is a decision which, under our form of government, the public must make.

We cannot, however, lightly dismiss all of our responsibilities in this matter by shifting them to the broad shoulders of the public. We must make up our own minds regarding what we believe about maintenance of water quality and provide the public with an honest and sound basis to assist him in reaching his decision. Which brings us full cycle back to our starting point of having to face up to a very complex and challenging question. Although I am not, and I am quite sure you are not, vain enough to believe that we can come up with complete and final answers here and now, I do believe that we can make some useful progress toward the answers we need.

Those who designed this program made an already difficult problem even more difficult by a ground rule with which they sought to anchor us speakers to terra firma and to prevent us from soaring into orbit in the stratosphere. This ground rule states "Remember that you are talking to professionals, not laymen, and minimize generalities and philosophy as much as possible." The qualification "minimize - as much as possible" provides a loophole of which I propose to take, indeed I must take, full advantage. Otherwise, our problem would be insoluble. I have a sneaking, though unconfirmed, suspicion that the program designers hopefully may have believed that all the subjects they propounded might be dealt with exclusively by an engineering approach, supported by incontestable facts and figures. I submit that the subject represented by the question "Must Stream Quality Be Maintained?" can be resolved only by venturing into the philosophical realms of emotions and of morals, as well as into the more prosaic field of engineering. Only a small portion of the answers to this question will come from manipulation of the slide rule. The major portion of the answers ultimately will come from the secret and poorly understood workings of the mind of that aggregate man, the public, and will be influenced by his emotions and, we hope, by his morals, when he deposits his decision in the ballot box.

In order to come to grips with our problem, which I already have delayed as long as I decently can, we must reach some agreement on definitions and limits of the subject matter. For example, what does the first word "must" imply. Among other things Webster says it means "obliged by logical necessity" and "morally required." Both of these are acceptable meanings for our purpose, but they do not go quite far enough. We must, and we shall attempt to, determine whether "must" means absolutely and without exception, or if it allows some latitude for the exercise of judgement. Also, it fails to take the time element into account. Does it imply that we must start maintenance now, or does it permit the flexibility which will allow us to justify postponement of action on an anticipated need to some future date when the potential need becomes an actuality?

Likewise Webster is of some help on "maintain", but again his definition, "To hold or keep in any particular state or condition," does not go nearly far enough. What state of condition must we hold? Must it be the natural state, the present polluted state, or some future improved state? If it is to be an improved state where do we draw the line regarding the degree of improvement?

I trust that we need not to go to Webster for a definition of stream, but his definitions of quality as "Natural superiority in kind" and "Excellence of character" fit right in with the state in which we would prefer to keep our waters. Unfortunately, we must temper this highly desirable state of affairs with considerations of practicality of achievement.

Let's decide just what we want to talk about so that we can confine our discussion within reasonable limits. I suggest as our objective the development of such guidelines as we can agree upon which will best serve our attempts to plan water quality maintenance programs. The aim of such planning should be to assure, within limits of available quantity, water of such quality at such places and such times as will best serve the public welfare.

The objective of water planning frequently is expressed as development of a plan which will assure maximum development of the region involved. I am not sure just what is implied by "maximum development" but I am inclined to think of it in terms of the most people that the area will support. I am not sure that the most people is what we really want. After all, the maximum development of a land area in terms of number of people is represented by our city slums. Obviously this is not a type of situation that we want, for most of our major cities, aided by both state and Federal governments, are spending huge sums of money to dismantle slum areas and distribute the overcrowded populations to other areas where they have more room and more healthful and pleasant living conditions. By analogy, the greatest possible number of people using our streams would reduce the streams to dead, lifeless, and stinking sources of contagion with minimum usefulness and no aesthetic appeal. I am quite sure that this type of maximum development neither is wanted nor will be tolerated.

It is for this reason that I prefer to state our objective as maximum service to the public welfare rather than as maximum development of an area. And it is around the problem of what water uses truly are best for the public welfare that all our vexations, our doubts, and our soul searching center. Is it possible that we are assuming too much responsibility in this area? Do we, as public health engineers, feel obliged in our water planning to evaluate all of the innumerable and highly complex factors that influence the public welfare? If so, we are setting ourselves an impossible task, for we simply are not equipped with either all of the knowledge or all of the wisdom necessary for the task. We are presumptous if we assume that we are so equipped. When we recognize this we can begin to think about the other disciplines that we must call on to work with us and assist us in reaching our decisions. I am sure we shall feel more comfortable about our problem when we reach this state of maturity. Even when we thus resolve some portion of our concern we still are faced with the fact that there exist within our own field of competence considerable areas in which we yet have much to learn. If there were no such areas there would be little or no need for the professional public health engineer and no necessity for the exercise of judgment. If we knew all we needed to know someone long ago would have produced a handbook, cookbook style, which anyone could follow to produce a sound water quality management plan. We soon would be out of work.

In seeking our guidelines let's start with such generally accepted precedents as we already have before we soar into the realm of speculation.

Probably our soundest precedent is that of riparian rights. In this country the riparian rights doctrine was borrowed from the English system of jurisprudence, where the doctrine had been developing for many centuries. This doctrine is law in about two-thirds of our states. It assures all owners of property adjacent to a stream the right to use of the natural undiminished flow of the stream with its natural quality unimpaired by upstream use.

The other third of our states employs the doctrine of prior appropriation. This vests the right of beneficial consumptive use of water quantity in the user who first establishes his right to such use. This type of use, however, is of a usufructuary character. Again turning to Webster we fine that usufructuary means having or possessing a usufruct, which is of little help. Tracking down usufruct, however, we find that this means "the right of using - the fruits - of an estate or other thing belonging to another without impairing the substance." This appears to imply, at least, quantitative use does not include permission to alter the natural quality of any water of the stream which is not used or which is used and returned to the stream.

Thus we have a clear, legal mandate from the public, through our laws on water rights, that the natural quality of our streams is to be maintained. I am not aware that either of the two doctrines awards the user of water the right to impair the quality of the stream provided he decides that it is too costly for him to maintain the natural quality.

The legal mandate is clearly supported by the emotional attitude of the public. Man has an instinctive affinity for water. His very body is more than ninety per cent of the stuff. The biologists tell us that life itself originated in the sea, and that somewhere along the evolutionary chain our ancestors emerged from their watery home to begin their struggle for existence on dry land. Man always has been restricted in his travels by the need for an ever present source of drinking water to maintain life, or else he has had to carry his drinking water with him. Before he was able to transport substantial quantities of water for considerable distances he lived, as a matter of necessity and of convenience, very close to a body of water. All of these associations appear to have left their imprint in that recess of the mind of Man in which his instinct resides. Man instinctively loves water. Even as a baby there are few pleasures that he enjoys more than his daily bath. As a child some of his happiest moments are spent wading in water, with or without shoes, splashing in it, and sailing toy boats on it. As an adult, water has a tremendous appeal when he seeks the recreation that is so essential to his welfare. He loves to swim in and under it, glide over it in a boat or on skiis, take fish from it, and just sit and look at it. On vacation he will travel hundreds of miles to enjoy his favorite body of water, be it ocean, lake, or turbulent mountain stream. His first requirement in considering a suitable location for a summer cottage of his own usually is that it be within sight of a body of water. But the sense of pleasure that he derives from association with clear, clean, sparkling water gives way to frustration, disgust, even rage, if the water exhibits observable effects of pollution.

I use the word "observable" advisedly, for people judge the condition of streams most often by what they can see and smell. Occasionally they may condemn a stream by the taste of their drinking water, but more often they are apt to blame the poor water plant operator for putting too much of "that chlorine" in the treated water. But when they see feces, condoms, toilet paper, rags, grease, and the infinite variety of other solids discharged from sewers floating on or bobbing in a stream, they know that stream is polluted. When they see excessively muddy or unnaturally colored water, they conclude that the stream is polluted. When a stream carries an excessive organic load which imparts that typical grey, dull, lifeless appearance the public knows it is polluted. When they smell the rotten egg odor of hydrogen sulfide evolved from sludge deposits or from a septic stream they are convinced that pollution is the cause. When they no longer can catch fish, or if their catch consists of carp or other scavengers and does not include game fish, they blame pollution. And I am not aware of many things in this life that can arouse such public hue and cry as the sight of a stream and its banks littered with dead and decaying fish. Even those who are not fishermen become indignant. Perhaps the uproar is aroused by the loss of a few hundred pounds of meat, but I suspect that more probably it results from revulsion at the visual evidence that the stream is sick with pollution.

These, then, are the sensible evidences of pollution which we must control. I am convinced that we have a mandate from the public, based in large degree on emotions, to keep our streams from looking and smelling polluted. Unless we maintain the waters of our streams in some semblance of their natural appearance the public will give us very little credit for our water quality control efforts, no matter what our success in controlling effects of unseen pollution may be. If the public frequently sees or smells the effects of stream pollution there will be very little incentive for them to continue to support water quality control programs.

The emotions which are involved in the public's reactions to what they can see and smell have led to legal means of protection against generally unpleasant conditions which arouse those emotions. This protection is provided by our ordinances on nuisances. These ordinances assure the individual that he does not have to put up with unduly unpleasant sights, odors, noises, and a multitude of other conditions to which his senses and emotions react adversely. The general principle that no one has a right to impose a nuisance on someone else has been accepted without question by those who have responsibilities for stream pollution control. Everyone in this business agrees that no nuisance shall result from stream pollution. Even those who reach the reluctant conclusion that economics dictate that certain streams must be abandoned to waste disposal insist that such use shall not result in production of nuisances, regardless of the cost of prevention. This insistence is reflected in the stream pollution control laws or regulations of practically every state. The portions of the codes involving nuisances reflect major concern over prevention of odor nuisances, since most of them specify maintenance of some minimum dissolved oxygen content, low though it may be.

Another principle firmly established by pollution control agencies also is based on the public's emotional reactions to nuisances. This principle is the almost universal agreement that all domestic sewage should be subjected to a minimum of primary treatment. Many state pollution control agencies also require that industrial wastes be subjected to equivalent treatment, which basically involves the removal of floating and settleable solids. Why do our control agencies generally agree on these requirements? We know that primary treatment accomplishes very little in the reduction of the unseen effects of pollution. The primary sewage plant effluent contains 60 to 75 per cent of the initial biochemical oxygen demand, 30 to 60 per cent of the suspended solids, and 25 to 75 per cent of the pathogenic bacteria. I consider the relatively small fractions removed as a minor accomplishment at best. It would be interesting to know how many primary treatment plants have solved dissolved oxygen problems. I suspect that the number of those which have accomplished this would be a very small percentage of the total that has been built. The usual primary sewage plant turns loose into the receiving stream at least one-half, and probably more, of the pathogenic bacteria in the raw sewage. This residue presents a health hazard to all who use the water downstream for recreation. My own reaction is that I would have little, if any, more hesitation in swimming in a stream carrying raw sewage than in the same stream carrying a primary effluent. I would not swim in either, and I do not feel comfortable boating on either.

In spite of the deficiencies of primary treatment we generally agree that it must be provided for all sewage and many industrial wastes, regardless of cost. I am convinced we have agreed to this requirement because it does control those things which the public can see and smell. The floating solids which offend the eyes and the suspended solids which produce sludge banks to offend the nose are controlled.

The benefits of preventing these offenses certainly are intangible ones to which no dollar and cents value presently can be attached. We accept the requirement of primary treatment on such an intangible basis without bothering to attempt a balance of costs against monetary benefits. Why, then, do we become so concerned over balancing costs against monetary benefits when we are dealing with the unseen effects of pollution, such as the hazardous billions of pathogenic organisms which escape from primary sewage treatment plants, or the dissolved organic solids in industrial wastes which may deplete the dissolved oxygen below levels that will support a balanced fish population? There appears to be a degree of inconsistency here, which may be one of the reasons for some of our soul searching over how much waste treatment we should recommend.

I trust we can agree at this point that we have legal support both in our water rights laws for seeking high degrees of waste treatment, and in our nuisance ordinances for essentially complete control of observable effects of pollution. It is my opinion that the public's affinity for water and their reaction, emotional if you please, to evidences of defilement by pollution have played an important part in the evolution of these laws.

Thus far we have not approached our problem from the standpoint of morals. It should be easy, it appears to me, to reach agreement on this phase of the problem. Either it is right for a municipality or an industry to discharge pollutional material which imposes on downstream users of water or it is wrong. I see little real difference between such discharge of refuse and that of pitching my garbage across the fence into my neighbor's yard as the easiest way to dispose of it, or of allowing my underground sewage disposal field to spew sewage across my neighbor's property line because it would cost me too much to repair it. I spend money to avoid defiling my neighbor's property. I would consider it wrong, and would be nagged by a very guilty conscience, if I did otherwise. Should the conscience of the corporation, be it municipal or industrial, be any less acute? Unfortunately the corporate conscience frequently appears to be much less acute, and at times even non-existent. Fortunately our society has laws to deal with its members who have no consciences. When persuasion fails the law should be brought into play to make those do right who otherwise would do wrong, or at least to stop them from doing wrong.

Perhaps you think I have talked too much about the law in my preceding discussions. I have intentionally emphasized the legal factors. I think we sanitary engineers and economists are prone to become so intent on our engineering and economic calculations, evaluations, and judgments that we are apt to forget the intent of our laws and to substitute instead our own opinions as guiding principles. Perhaps our opinions are more valid in this particular field than are the laws of our land. If so, ultimately, the laws will be changed to reflect our opinions. Until that time, I consider it incumbent on us to bring our recommendations on waste disposal into line with the intent of our laws.

In patterning our recommendations after the intent of our laws we must follow the interpretations of the laws evolved by the courts. The judicial interpretation of the doctrine of riparian rights, for example, appears to be leaning in the direction of reasonable use that will not interfere unduly with downstream uses, rather than demanding strictly that there be absolutely no interference with such uses. This trend immediately brings us face to face with decisions regarding how much interferences with downstream uses will we permit. Let's see what precedents we have to guide us in these decisions. There may not be all we need, but at least they can serve as a starting point.

Our best precedents probably are those used as guides or as requirements of state water pollution control agencies. I had occasion fairly recently to review state practices in this matter, and found that there is more agreement among the states on certain factors than you might expect. Almost all who have produced official statements on requirements prohibit floating solids and suspended solids that will cause sludge banks. About two-thirds of the states have official requirements or are members of interstate groups which seek to maintain monthly average MPN's of coliform organisms of less than 5,000 per 100 ml for both sources of domestic water supply, and for general recreation, such as fishing and boating. About the same number specify average MPN's of less than 1,000 per 100 ml for swimming and other water sports involving body contact. Again, the same two-thirds of the states seek to maintain average dissolved oxygen concentrations of at least 5 mg/l. Most of the states recognize the Public Health Service drinking water standards both for finished drinking water in toto and for streams as regards those numerous constituents, principally inorganic in nature, which are not eliminated or controlled by conventional water treatment methods. Finally, practically all states recognize the public's insistence that fish be protected. This recognition is reflected in requirements that constituents harmful to fish and other aquatic life be held below toxic or lethal limits.

These combined requirements, on which at least a majority of the state pollution control agencies agree, furnish a substantial base on which to build in reaching decisions regarding the degree of waste treatment needed to maintain water quality. I judge that application of these requirements, plus others which are not covered but may be selected at comparable levels, will assure maintenance of water quality which will serve the public welfare.

Thus far I have not touched on water uses as a basis for determining needed water quality. I am sure I do not even need to suggest to this group that water uses must be considered. If there is no use of a particular stream there is little justification for concern over water quality. I maintain, however, that there are few streams in this country which are so isolated that they cannot be reached by car or by boat for fishing and other aquatic recreation. Streams protected for fish and other aquatic life, and for recreation, will have water of a quality which will meet the needs of most other uses to which they may be put. Even if we can prove now that a stream, or a portion of a stream is inaccessible, how can we say that fifty years from now, or within whatever period we select for planning, the same stream still will be inaccessible? While we may not insist on immediate protection of a completely isolated stream, in letting the bars down we must make it clear that this is a temporary expedient only and the bars will go up again as soon as accessibility to the stream may be imminent.

Many years ago our progenitors in sanitary engineering propounded an engaging proposition to which those responsible for sources of wastes immediately and enthusiastically agreed, and unswervingly have supported since that time. This proposition is that all streams should be used, where needed, for waste disposal up to the maximum assimilative capacities of the streams. In the beginning of my professional career I subscribed to that view and spent a great deal of time sampling, analyzing, and computing to the first or second decimal just what the assimilative capacities of streams were. I do not deny that I found this entrancing. Gradually over the years, however, I have become disenchanted with that philosophy. I cannot pinpoint my reasons for this disenchantment. Perhaps the one factor, more than any other, which has changed my viewpoint has been my realization, gradual at first but finally overwhelming, that we are steadily losing the battle against stream pollution. Perhaps I have associated an undeniable result with the wrong cause, but I cannot help but believe that the philosophy of maximum use of assimilative capacity has been one of the major stumbling blocks to effective stream pollution control. At least twenty years ago I heard Dr. Abel Wolman expound the philosophy that we should obtain all of the waste treatment that we could within economic limits. At that time such a thought was heresy. Yet last December in our Nation's capitol a substantial sector of the National Conference on Water Pollution agreed in principle with Dr. Wolman's earlier stand. Please note such panel conclusions as:

1. "The users of water do not have an inherent right to pollute";
2. "Users of public waters have a responsibility for returning them as clean as is technically possible";
3. "We recommend that the conference express its conviction that the goal of pollution abatement is to protect and enhance the capacity of the water resource to serve the widest possible range of human needs, and that this goal can be approached only by accepting the positive policy of keeping waters as clean as possible, as opposed to the negative policy of attempting to use the full capacity of water for waste disposal."

It appears to me that every avenue of approach that I have taken in seeking an answer to the question "Must Stream Quality Be Maintained?" has led to the same conclusion, that we must maintain stream quality at a high level indeed. These approaches have included consideration of our basic water rights and nuisance ordinances, the public's emotional involvement and rights in the matter, the rights and wrongs, or morals, of the problem, the requirements of state pollution control agencies with long years of experience back of them, and finally the latest expression of opinion of a substantial segment of the profession which is concerned with water quality and the effects of wastes thereon.

Against this impressive array of affirmative answers I am aware of only one negative answer that may be advanced. That is the common, inevitable defense of those who oppose corrective measures that "We cannot afford waste treatment." My reply is that I have seen a lot of municipal and industrial waste treatment plants in my day and I am not aware of a single town or industry that has been driven into bankruptcy by having to finance waste treatment facilities. I do know of two small pulp and paper mills that reached the final decision to close down at the times when pressure was brought on them to provide waste treatment. Both of these were marginal operations, at best, with daily capacities of 80 and 120 tons of paper, which are small mills indeed. I am sure that many economic factors, exclusive of the cost of waste treatment but including dwindling supplies of pulpwood, entered into the decisions to close. While we must sympathize with the limited numbers of employees that lost their jobs, I cannot believe that such marginal plants contributed substantially to the welfare of the communities involved.

I admit that I did not know where I was headed when I started preparing this discussion. Instead of attempting to guide my arguments I have tried to let them lead me to a conclusion. Probably the rambling nature of my discussion reflects this groping. In any event, I believe it has led me to a more honest and sincere conclusion than I would have reached if I had formed a preconceived answer. My first reaction that a simple, unequivocal "Yes" was the only answer needed has been modified somewhat, but I still believe that a positive answer, with explanations and possibly a few exceptions to prove the rule, is the proper answer.

DISCUSSION

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It's pretty tough to follow a man like Kit, so I'm afraid you're going to have to put up with some rambling thoughts of my own. First, I can't disagree, I don't think, with practically anything that Kit has covered. Perhaps I can give you some of the reactions that I had as I read his paper previously, and also as I listened to it a few minutes ago. I think he laid his hand on one problem that probably the majority of us have. He said that he started out with a preconceived idea and has been struggling with this idea - I don't know whether he said, but he implied - the rest of his professional life. I think we have arrived at the point where we need to really clarify our own thinking and tell ourselves and the public why we think water quality ought to be maintained. And this gets to be quite a struggle because there are many things. He mentioned morals, emotions, laws, and so on. If we're going to make any success or any progress in this field, we have to get down to specifics. Let us go to something in the medical profession to draw a parallel - this problem of overweight and underweight. The doctors have now convinced us fairly well to think that overweight is something to be avoided. They tell us that this is likely to lead to heart ailments, and so on. Now let's not overlook the fact that they have used emotions - our emotions and our fears of heart diseases and others - to accomplish their objectives. First off, let's not look down our nose at this motivating factor of emotions. In a democracy many of the things which we accomplish are accomplished by appealing to emotions. Once we get these emotions in the proper direction, and I think that here we need to have not *unreasoned* emotions, but reasoned emotions. I believe that we need, as I have said, to give the public a handle to grab hold of. Something that they can understand. And I think that we very definitely have to give it in their language, not our own.

Let's not overlook the fact that we've spent three days here pretty much convincing each other. I think we need to spend an equivalent amount of time convincing the public. We've gone a long ways down this road already. The past program - I sometimes refer to it as the Schwob era - has done an excellent job of sales. The recent period has been one of trying to produce a product which will live up to that sales. We've sold the public and they have reacted, perhaps with emotion, that they should do something about this water quality problem. Now it's our job to produce, and we have sat here for several days and realized what a difficult job this is, to produce. Part of this difficulty is a stumbling, or a choking, on some of the smaller aspects of the problem. We are sometimes afraid to use the information which we have, and let the smaller parts that we do not have govern our lack of action. I think action is going to be our key word in the years to come if we're going to stay in this business. We're going to have to move ahead with the information that we have and always try to improve our techniques, but don't be afraid to use what we have. If a recreational specialist can determine that a water based recreation is worth 50 cents or a dollar per day to me, I ought to be able some way to put a handle on the value of water - clean water, if you will - to a municipality or to an industry. Sure, we're going to have to guess a little bit, and we're going to have to stick our necks out a little bit, but unless somebody sticks their neck out, we will never make any progress. Haywood has a statement that we kick back and forth at each other from time to time - "You can't correct nothing. You have to have something to start with if you're going to correct it." And I think this might well be our thought in the future.

Eventually I think that economic considerations will result in water quality rationing. I think that we need to think more as we move along about the real effect of the lack of water quality on many of our economic considerations - industry, if you will. I don't think we quite realize how much poor water quality can damage industry, but I don't think for a minute that economic considerations are going to be the sole determinant. Kit has put his finger on the fact that emotions play a big part; morals play a big part; people want recreation, and sure, they want jobs, too, but they want recreation, and they're going to be willing to pay for it. Now we get down to this idea of what can they pay for and what can't they pay for. The idea that an industry or a municipality cannot pay for waste treatment is a bunch of bunk in my feeling, and I'm sure it is in Kit's. They will be able to afford anything they want bad enough. Take your own household. As far as the basic needs of living, few of you need telephones in your homes. You may need it in your business, but in your homes, few of you absolutely need them. But you rationalize to pay - sometimes a pretty good telephone bill. Few of you absolutely have to have electricity. You could get along with kerosene lamps, but few of you will go back to kerosene lamps. You can take this same thing along automatic heat - you could go down and stoke a furnace, but you won't. You will afford the things you want. And after all, people and industry - municipalities and industries - are nothing more than collections of people.

When thinking and working in this field of water quality, we've got to keep a balance. The middle of the road is still the best place to be. I don't think that we can go overboard on either side. I don't think that we can ever hope - nor do we want to return our streams to the condition they were when the Indians inhabited the country. Nor do I think that we can afford to live in a stinking mess, if you will. So we're going to find that middle of the road. I think this is very aptly put by Bill Davis in his comment on one of the papers the other day. I've forgotten which paper it was exactly, and I don't know that I can paraphrase him exactly, but he made a reference to educated people without anything to drink versus uneducated people riding around enjoying themselves in speedboats. Well, obviously, these are the two absurd extremes, and we've got to find a spot in between that's most comfortable.

I think that's about all that I have to say except, there's one other thing - Kit apologized somewhat for the frequent reference to laws, but let's not overlook the fact that laws are an expression of what people want, although very frequently such laws are vague and sometimes inaccurate because the lawmakers themselves have not been given the assistance to truly understand what they are legislating, and they put it in general terms. They expect the technician to add the meat to the laws. They expect a proper interpretation, and therefore I think it's our responsibility to give these laws substance that makes sense.

GENERAL DISCUSSION

WEISER: We have discussed here from time to time the whims and the vagaries of management outside of our governmental agencies - the public - whether the public is going to want or demand a lake just, perhaps,to have its own recreational area, and a number of other emotional considerations have come up in almost every session. In fact, there have been some emotional discussions within our own frame of reference. I'm going to come back to a point that I was trying to make the other day, and which I will probably come back to from time to time as I remain in this business, and that is that when you want something bad enough, you'll go after it. Now, these people - we feel they want water, they will go after it, and they will get it. If we want help in knowing and projecting the extent to which they're going after this - if we want to solve this problem - I suggest that we go to the right place to help measure this intangible area, because it is not so intangible. There are limits within which we can predict the emotional response to these things. We have not called upon the right people to do it. We know ourselves that we are dealing with gross approximations many times. This is not an exact science. I think in order to help us with some of these outside areas in which we are not competent, it would do us well to call upon some professional help. I wonder if anyone has ever called upon a social psychologist to evaluate this realm in which we are not able to deal very competently ourselves.

DWORSKY: I think this is a fine thought. I think it ought to be done. I would say that ten years ago we took this matter up with the Navy up in Long Island in order to try to encourage them to help us in determining something about the emotional responses of people to this matter. Under the stimulation of Cy Everts, during the last 6 months we have again written a piece proposing this to one of the more important and well known research organizations in one of the important universities in the country, and we met with those people, and we couldn't get to first base with them. The reason for that apparently is that they're willing to deal in the social sciences, but afraid of moving into the physical sciences in the resources area for some reason. I don't think this should stop us. I fully agree with you. I don't think we should stop trying to get somebody. This is a most important area.

WEISER: They are improving their techniques as we, of course, are improving ours.

HAYWOOD: Every now and again I get a feeling that we have taken a stand - maybe we're not yet stuck with it, but we're adhering to it without looking too carefully at the total implications. Are we correct in saying that no one should discharge anything into receiving waters? Should we say that even highly treated waste can't be discharged? Should we say that waste having no treatment can't be discharged? Think about that just a minute. Let me give you an example that has me running around in circles. I'm speaking of a plant which I know well. I was acting as consultant on it from the time a plant site survey was begun. It was a plant that originally was planned to produce titanium metal but eventually developed into a plant that produced titanium pigment - a completely inorganic process - with inorganic wastes, principally ferric chloride. The plant was located on the Tennessee River and historical records showed that stream flow of 8,000 second feet occurred once every umpteen years - I've forgotten how many. We calculated the contaminants, chlorides, iron, and other contaminants which would be produced at that plant site at its ultimate development. In other words, we asked management and were told what they had in long-range plans. We calculated what the effect of this discharge of all of these wastes on this stream would be, and it appeared to us that the chloride concentration might be measured as much as 6 parts per million and the iron concentration might be increased anywhere from 1 to 2 parts per million. We asked for, and were granted the right by the Tennessee Department of Health, to discharge wastes into that river without treatment on a trial basis. The yardstick was to be whether or not conditions in the river changed to an objectionable degree. We volunteered to set up a very rigorous monitoring system - to staff it, to pay for it, provide the State monthly records. As a result of this analytical program the stream was very carefully surveyed - a biololgical survey which I mentioned earlier this week and which I think is the only real means of determining the effects of waste on receiving. The survey took three weeks. It was done by a team of experts from the Academy of Natural Sciences of Philadelphia. Management has their report in the files for reference if claims of damage are ever made. By avoiding the construction of these treatment facilities (incidentally they were designed and the designs in blueprint form are in the files right now ready for use when the need arises), the company has avoided an expenditure - a capital expenditure of two or three hundred-thousand dollars, and an annual operating cost of an equal amount. Was Tennessee wrong in giving us permission to discharge untreated wastes into this stream? I don't think so. If we had been on a small stream certainly they would have been wrong, and I don't think industry would have made the request it did, as a matter of fact. I know for a fact that a number of plant sites were abandoned, although many attributes were favorable, because of the lack of water to receive untreated wastes. Maybe there is a middle road, as Paul says. I'm sure there is. But I get a little frustrated when I hear, "No, you can't put any untreated wastes into the stream," with no qualifications, no explanation.

THOMAN: I simply posed the question, "Does this give the company the inherent right to continue to pollute, or to continue to put those things in there?" Suppose some other pigment plant wanted to come in there and two of them together would be more than the stream could receive? What's your answer to that? Is that morally right? Morally wrong?

HAYWOOD: I have an answer to that. I don't think the company should be given a continuing right or a perpetuating right. I think this should be a temporary affair - an interim affair - and that their "right", if you want to call it that, to discharge now without treatment is one which is subject to review and to necessary restriction as other people want to enter. If somebody else wants to put in a pigment plant, or any kind of plant up the river, and it became necessary, I think that company should be required to put in a reasonable amount of treatment. Now there's going to be an end to that. It would certainly be simpler for Jones to say, "No, nobody can discharge untreated wastes into this river." But let me give you one more point: I was in Louisiana last week and I was talking with Kenny Biglane. In our studies we assume that any contamination - present contamination due to man-made wastes - within 50 years is going to be eliminated. Kenny says, "Heck, no - face facts. The oil industry is the big industry in Louisiana. They bring into this State three-hundred-and-some-odd million dollars a year. They are projecting that they can expand and will expand to double or triple this rate of production. Face the facts of life. They're not going to clean up all their waste, and we can't put the pressure on them to make them do it." He cited an experience of going to the legislature with a very carefully prepared bill, one well documented with a lot of data, and was turned down because the man in whose region the pollution problem existed happened to be either a friend of one of the large industries, or happened to have holdings himself, and cast the deciding vote against the legislation. What we want, and what we get at times are dictated by rather small groups. The over-all public isn't protected as it should be. Why? Simply because it doesn't understand the problem. I think that's one of the roles that Public Health Service must play to get our knowledge across to the lay public so when these bills come up the legislative bodies will have some knowledge, some background, other than the immediate economic background. I don't know if we're going to get any people like that, but I certainly think it's a worthwhile goal.

SVORE: I think this is a real important subject. I certainly agree with Kit that we shouldn't load our streams to the hilt, and I think this should be a very definite policy of Public Health Service. You quoted one of the conclusions of the conference in Washington which was that industries and municipalities do not have an inherent right to pollute. Now this sounds good, and I think it's basically a good policy, but we actually don't believe it, if we define pollution as anything that changes the quality of water into which we discharge the waste. With our present competence in the field of treatment we never treat to 100 per cent under any conditions, even when we use it merely as cooling water. Heat is pollution - it reduces the oxygen capacity and so on and so forth. So we may say on one hand that we are against a philosophy that gives industry an inherent right to pollute, but actually we don't go along with it in actuality. We acknowledge that a municipality has a right to pollute to the extent of discharging a waste that has been treated to 90 per cent reduction in organic matter, but maybe what we need is a new terminology in admitting that industry and municipalities have an inherent right to discharge a waste with some pollution left in it. In other words, they have a right to reasonable use. I think herein is where we get to the point, Bob, where it's a little difficult to answer your question. The industry you referred to had an inherent right - an unwritten right to pollute that stream, and I certainly would not want to be taken out of context in making that statement, which was a right only to its reasonable use. Now in your instance they were allowed to discharge their waste without any treatment. Well, in one industry this might be all right, and I can certainly visualize many industries located in exactly the same spot that would not have been granted the right to discharge raw waste, because of what it might ultimately do to the stream. I would hate to see any state or the Service adopt a policy where industry is given a right to use any river to its maximum so there is no capacity left in the stream for the next plant. In the next 50 years we will probably arrive at a point where all streams will be used to their ultimate even if all industry and municipalities treat to their ultimate under present day knowledge of treatment. If they do not treat to their ultimate there will be no room for a new industry, but if the industries that are there treat to a reasonable economic feasible limit, we are at least leaving the door open for the new industry when it comes along.

FLANNERY: I'd like to see if I can make a statement to tie together the morals and something on the psychology and perhaps economics. At the outset I'd like to get the statement very well - Kit's statement very well - the public interest concept, the general welfare concept are moral concepts. They indicate what we regard - what society regards as good, and this is really the essence of morals. Now the handicap that I see that pollution control advocates have worked under is in part a handicap they have invited themselves - upon themselves - because of their own terminology. Ten or twelve years ago when I was looking at this problem just as a graduate student with no particular zeal involved here or heart or conviction, I was misled by the term "complete treatment". It was a long time before I found out "complete treatment" isn't in any sense complete. It's complete only as far as - this is a nice word - it's completely all that we can do, probably. Another statement which is a similar handicap - may be a more extensive one - which we encountered much more recently. The same statement has taken 4 or 5 parts per million in dissolved oxygen. This is a magical thing and relates to BOD, which is much more magical to me - marvelous mythology. I've found in reports a statement that 5 or 4 ppm had no dissolved oxygen damage level. Well, I had enough suspicion to know that this meant no damage level within that compass of inadequate parameter of oxygen. And gee, why say this if it doesn't mean that, because later on a guy will read this and you've said that we reach this, and there is the obvious invisible damage in here. Now Bob Haywood's statement - I'm really very much pleased - because to some extent he was talking like an economist. Maybe I might even say reasonable, which is what the economist and we all strive for. Here we have - I think the word "pollute" or its infinitive "to pollute" is a handicap. I would say that when this firm put the waste material - the liquid waste material in the Tennessee stream, that since the pollution control administrator - the experts - did not consider that as having an adverse - a significantly adverse effect for some duration of time, that they were not permitting "pollution". The economist would say, "I don't like the idea. Maybe it's necessary that every stream in the United States must be water quality that's equivalent that, to say, drinking quality standards." Maybe at some time we'll have to get this far. I would pose this question and the question that I think the economist would ask - "What do we get for our money?" First, how much does it cost, and what do we get for our money? Unless you can answer that question pretty explicitly, I don't think you've done the job. This is a question that relates to this social psychology - to the morals. Is it necessary that we have complete treatment? What if we don't take this 100 per cent out, what does happen to the quality of the water? What effect does this have upon the uses that we intend to have for that body of water? This is what I keep pounding on. Our reports ought to say, we ought to identify here - get out flat on all fours on these inarticulated major premises - our assumptions, our considerations - when we say that a condition will exist, tell me what it is. Give me a four letter word if they are necessary, and give me some numbers if this is going to be convincing. Now this would force our thinking to be more rigorous when we know it, say it; if we don't know it - if we're saying this is our judgment and there are unknowns in here, give me some of the dimensions of the unknowns. What are the unknowns? If it's necessary to take out certain pathogenic things that we suspect are in there, what are they? This is something the public has to know. This is not just private funds to public use through taxation, or all the ways that government acquires money. It's also, as Bill Davis pointed out there, should we put this big chunk of money into water quality safeguards, should we put it into national defense, should we put it in education, highways? To what degrees do we apportion this chunk of money among these demands? This doens't leave the problem entirely back in you lap - and say that you haven't done the job. It means that the team from your Public Health engineers and the social psychologists that we've invited in today have to each look at this question and see to what extent can their system of knowledge contribute to its answer.

SCHEIDT: I'm not sure I want to get up, Kit. Not being a sanitary engineer I enter this debate with some fear and trepidation, but I'm thinking somewhat along the lines that Jim - with a little different slant, because I'm neither an economist nor a sociologist - I'm a planner. As a planner I am concerned with looking forward, not just concerned with what we have now, but looking forward to what we are likely to have in the future. I get a little bit frightened when I think about 330 or 350 million people in the United States with an increasing standard of living, so that instead of working 40 hours a week, we're going to have people working 30 hours a week, 25 hours a week, and instead of an average family income of maybe $5,000.00 a year, years from now they may have an average family income in terms of dollars equivalent of $10,000.00 a year, or more - lots of leisure time. I think there's another barometer here which we might very well think about and introduce into the debate. I believe that within industry and business and economics itself, we're going to find some weapons or some arguments between industries, if you will, that will move in the direction of further efforts in cleaning up streams. With all of this leisure and all of this income, there's going to be a lot of recreation, a lot of leisure time to take up, and industry itself isn't unaware of this. I'm told that the recreation business as a whole even today amounts to something like 40 billion dollars a year, and that's not hay. Within that recreation business, an awful lot of it is outdoor recreation. Most outdoor recreation is water oriented. I doubt very much whether boat manufacturers, the spinning reel manufacturers and all the fancy fish lure manufacturers and the others, as well as the skin divers, and many, many other recreation services, are going to let this bonanza go without some challenge. They, themselves, I think are going to make an awful big effort at cleaning up the streams, too, and they're on our side, also. I thought I would just drop that in.

REED: I think this goes back to the first comment that I made, and this is that we have to tell people why, but we also, must tell ourselves why, because unless we understand ourselves we're not going to be able to tell other people. We can take this whole range from whether we should have primary treatment up to whether we should have tertiary treatment. I happen to be working in an area now that water is going to have to be re-used many times, and we don't think any more in terms of whether we should have primary treatment or not. The question is whether we're going to have tertiary treatment or not, and whether it's going to get out the things that we need to get out, and the reason why is that eventually it's going to put a lid on the economic development of the state, and the people understand this.

POSTON: I think it's pretty generally concluded that we need to maintain high quality water, the highest possible in our streams. I don't think we can kid ourselves that - with a lot of new kinds of waste detergents, large quantity of waste and the same flow we have in our streams - we're not going to have difficulties in maintaining water quality. I think one of the biggest deterrents to getting some of these objectives, you might call them, on maintaining clean streams is some of our human frailties on the part of people to stand up and say "We've got to have this." Part of that stems from the fact that we're human beings and we approach problems from different angles, and I might cite one here. It pertains to a town on the Mississippi River. This town empties into the river some thirty-thousand PE equivalent, plus an industry with maybe two or three hundred-thousand, and the town - or the State - across the river from this, well, we don't have any problem there when it comes to interstate enforcement action. But then just about 6 months later they require the small town of about 700 people to put in a sewage treatment plant on this same Mississippi River just about 10 miles below this big town. Well, is there any reason? I think this is the scheme that they're using to get this river cleaned up, and forthcoming in the very near future the larger town will be made to clean up. It's just a little bit of slant at getting this job done. I don't think there's any question but what we must maintain our water quality, and I think it's up to us to have this as one of our objectives - one of our prime objectives.

Principles and Policies for the Evaluation and Reimbursement of Water Supply and Pollution Abatement Benefits from Federal Water Storage Projects

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Introduction

This paper deals with the problems associated with evaluating and paying for the benefits derived from the use of water stored in Federal reservoirs for those purposes which are the concern of the Public Health Service. These are municipal and industrial water supply, and water pollution abatement by means of dilution through augmentation of low river flows. These purposes are hereafter called simply "water supply" and "dilution" or "low-flow augmentation", as the case may be. The paper is confined to a discussion of the principles and policy issues involved. If and when these principles and policies are agreed to, it will be desirable to prepare more detailed procedural guides for their effectuation, but no attempt has been made herein to delineate such procedures.

As a basis for the discussion of these problems, it is desirable to make clear certain tenets or concepts on which the discussion has been based. These are:

1. Primary effort in water pollution abatement should be oriented toward the reduction or elimination of polluting wastes at the source, by means of waste treatment plants or other means.
2. Dilution is not a substitute for waste removal, but should be looked upon, rather, as a supplement to a program of adequate treatment.
3. The costs of waste treatment or removal should rest first with those producing the wastes, but, beyond this, the costs of storing dilution water producing widespread benefits should be non-reimbursable.
4. In providing storage for municipal or industrial water supply, the necessity of providing additional water for the dilution of the treated waste effluents resulting from its use should be recognized.
5. Water quality management is an integral part of the concept of planning for comprehensive river basin development; in this sense, quantity and quality are inseparable components.

6. In developing Federal reservoir sites, every effort should be made to conserve their full potentialities for optimum development.

While the measurement of benefits usually enters into the formula aspects for determining the costs to be assessed against or allocated to the various purposes of a multiple purpose Federal reservoir project, the actual measurement and evaluation of the benefits themselves is a separate problem from that of deciding who should pay the costs of providing them. An attempt is made to deal separately with these two problems in the following two sections, although there are places where the nature of the problem and the direction of the discussion makes this difficult or impossible.

Section I

Criteria for Assigning Water Supply and Pollution Abatement Benefits to Federal Storage Reservoir Projects as a Basis for Determining Reimbursement Policy.

(a) Water Supply. The basis for including water supply storage in Federal projects, and the requirements for the reimbursement of the costs thereof, are specifically prescribed in P. L. 500 - 85th Congress, and need no further elaboration here.

(b) Pollution Abatement. Decisions regarding the reimbursement policy to be followed in dealing with pollution abatement benefits resulting from releases of water stored in Federal reservoirs are complicated by questions of public policy concerning the use of dilution as a means of abating pollution. Two categories of benefits are involved; incidental benefits, and planned benefits.

1. Incidental benefits. When augmentation of low stream flows results from the operation of a Federal project for other purposes, such as flood control, navigation, or municipal water supply, an incidental improvement in the quality of the waters of the stream often takes place. This improvement may be due to the dilution of wastes or other pollutants which the stream carries, to an increase in the dissolved oxygen of the stream, or perhaps to a lowering of its temperature. Detriments may also occur, as when oxygen deficient water is released from the bottom levels of reservoirs. While these benefits are generally not planned for in the design of the project, and usually do not enter into the computations of benefit-cost ratios, they are nevertheless very real and should in some fashion be credited to, or in the case of detriments, charged against, the project. This is usually done by means of a separate discussion or presentation in the project report, including a monetary evaluation wherever this is possible. Under the circumstances described, it appears that since the augmented flows would occur whether or not pollution existed, it is entirely proper to credit the Federal project on a non-reimbursable basis with these incidental pollution abatement benefits,

even where the improvement in stream quality results in a windfall benefit to those causing pollution in the stream by making it possible for them to postpone construction of treatment works which would otherwise be required. One caution needs to be raised regarding such cases, however. Because of population increase, economic growth, or changes in stream quality standards resulting from adoption of new sociological or environmental objectives, such windfall benefits should never be looked upon as continuing on a permanent basis. Their evaluation should be based upon the timing of future stream quality requirements as determined by the best possible projections of probable future demands upon the stream, and the duration of the benefits and the corresponding credits to the Federal project should be limited accordingly. Thus, at the appropriate future time, polluters should expect to install treatment works to meet stream quality needs.

2. Planned benefits. In addition to the situation described above, improvement in stream quality through release of stored water may be specifically provided for in planning a water storage project. At the present time, no general authorization exists for the inclusion of this purpose in the design of Federal projects, but in several instances it has been specifically included in the authorization of individual projects, and studies now underway are recognizing this potentiality. It is expected that such authorizations may increase in the future, and the problem of assigning responsibility for meeting the costs of providing such benefits therefore takes on added significance.

The determination of reimbursement policy with respect to stream quality improvement benefits produced under the planned conditions just described is much more complex than in the case of incidental benefits. At issue is the question of the degree to which non-reimbursable Federal expenditures, that is, contributions by the Nation at large, are justified for this purpose, as compared with expenditures which should be made by the pollutors in the first place, for waste treatment works or other pollution abatement measures available to them. Specifically, the question is that of determining the level of waste treatment which pollutors should be expected or required to provide, before pollution abatement by dilution at Federal expense may be considered justified.

Said in another way, the determination of the justifiable degree of planned Federal participation in stream quality improvement endeavors, through low-flow augmentation, requires first a determination of the amounts, kinds, and degrees of concentration of those substances which may properly be allowed to be discharged into a river, and the degree of dilution of these wastes required after treatment to maintain adequate water quality, as determined by appropriate authority.

Determination of Degree of Treatment Required Before Dilution is Warranted

A rational approach to this problem is provided if it is recognized that the waters of rivers and lakes are generally considered to lie within the public domain, and that they may be withdrawn for use only with the permission of the particular govermental agency, usually the state, having jurisdiction in each case. This is true under both the riparian rights, or reasonable use, doctrine and the prior appropriation doctrine. Under the reasonable use doctrine, the public has broad general rights in the waters of a stream, but the owners of property abutting the stream have the right to the reasonable use of the waters. Except for such beneficial consumptive uses as drinking, stock watering, lawn watering, etc., however, each riparian owner must, after use, allow the stream to flow undiminished in quantity or quality to the next user downstream, unless he is legally authorized to do otherwise. The prior rights doctrine provides for allocation of waters for beneficial consumptive uses but does not permit the user to discharge indiscriminately polluted waters back to the stream.

The public has broad interests in most streams with respect to sources of water supply, fish and wildlife resources, recreational values, and esthetic and environmental influences. An additional point to bear in mind is that, except for water consumed through evaporation and transpiration in connection with irrigation usage, and the very small amounts of water actually consumed by people and animals, withdrawn waters are largely returned to the river after use. Because of this latter fact, withdrawn water should preferably be looked upon as a service facility rather than as a commodity, as has heretofore generally been the case.

As a service facility, withdrawn water is used mostly as a solvent, cleanser, transporter or coolant, to carry away sewage and other waste products, dirt and grime, and heat, following which, because there is nowhere else to dispose of it, most of it is returned to the public domain in a lake or river, usually with most of the substances it was required to transport left in it. Viewed in this light, the service which the water user receives is essentially that normally provided by a rental facility. The rental price, in the case of water, of course, is the cost of the facilities required to withdraw, use, treat and return it. Under these circumstances, it is only proper that the rentor should, at his own expense, remove the transported commodities from the vehicle and otherwise make it suitable for the next user, before returning it, or compensate the owner (the public) for the cost of such removal. This is particularly true where the transported materials are obnoxious. This principle is entirely in keeping with the water rights doctrines under which the waters of the U. S. are managed.

During the earlier period in the Nation's history when population was less dense, there was little recognized and accepted stream damage, and disposal of wastes into streams, in many instances, did not conflict seriously with other users. Today, with increasing congestion, close proximity of uses and users, and almost universal use of water for flushing away wastes, the discharge of large quantities of wastes into streams impairs their quality to the detriment of both downstream users and the general public. Under these conditions, the use of a stream as a vehicle for the disposal of sewage or other wastes is contrary to the public interest and the doctrines of water use.

Unfortunately, under current practices and within the limits of existing technical knowledge and the presently accepted limits of available economic resources, water is the cheapest convenient, generally accepted, means of transporting and handling sewage and some other offensive or detrimental wastes. Thus, with some small scale exceptions, the discharge of waste waters into public water bodies is at the present time the only practicable method of disposing of them. Under these circumstances it is obvious that water users, if they are to meet their obligations to each other and to the general public, must minimize the adverse affects of presently accepted waste disposal practices by treating their wastes, before discharging them into streams, in such manner as to remove as much of the detrimental substances which they contain as possible. The provision of water at national expense for the dilution of wastes, as a means of reducing stream damage, in lieu of proper waste treatment, is, under this premise, not only contrary to public policy, but constitutes a subsidy to the pollutor, and should, therefore, not be condoned or proposed. This general principle has been clearly enunciated in the testimony of Public Health Service officials before Congressional committees.*

Acceptance of the foregoing premise requires that "proper treatment" be defined. It is, of course, not possible, at any presently acceptable economic cost, to remove all polluting substances from used water. However, in the case of domestic sewage and of industrial wastes of a similar organic nature, a combination of primary and secondary treatment can, at quite reasonable cost, remove, on an average, at least 80% of the oxygen demanding organic wastes. Lagoons or "polishing ponds" and other treatment processes can, where necessary, further reduce the BOD remaining in secondary treatment plant effluents at additional cost. It would appear, therefore, that a minimum of secondary treatment or its equivalent is not an unreasonable prerequisite for crediting non-reimbursable pollution abatement benefits to Federal water storage projects. Similarly, with some other types of industrial pollutants, process improvements, treatment, impoundment or other processes can substantially reduce the amount of polluting material allowed to enter a stream. It would appear, therefore, that only after all practical treatment measures have been applied, such as the above, should planned non-reimbursable pollution abatement benefits from low-flow augmentation be credited to Federal projects. On this point, it should be noted that such levels of required treatment conform to the conclusions reached at the National Water Pollution Conference in Washington in December 1960, that "the objective of pollution abatement measures should be to keep national water bodies as clean as possible rather than to attempt to use the full capacity of water for waste assimilation", as heretofore advocated.

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* Statement of Assistant Surgeon General Mark Hollis before the Senate Committee on Public Works:

> "...in line with the Federal Water Pollution Control Act, pollution abatement should be regarded a primary responsibility of state and local interests. We, therefore, suggest that the record be clear that low-flow augmentation should not be used as a substitute for sewage treatment works required by State authority or contemplated in comprehensive pollution control plans prepared under the Federal act. However, it is often difficult even with the best known treatment practices to preserve quality of water in streams suitable for normal re-use purposes during periods of minimum flows. Augmentation of low flows during such periods would be highly beneficial...."

In some situations and with some classes of pollutants, no methods of treatment are at this time available at any reasonable cost. Examples are the plant nutrients remaining in sewage after treatment, certain persistent industrial chemicals, acid mine drainage, heat, and salts dissolved from natural deposits. To be sure, a procedure can be instituted for reducing or preventing some of these substances from entering a stream in some instances, but in many cases no economical corrective measures have yet been devised. Furthermore, a considerable part of the nation is dependent for its economic well-being upon industrial establishments that produce wastes, such as these, which, at the present time, are difficult or impossible to treat at economical costs. Under the latter circumstances, sound judgment should be applied to aviod an unreasonable insistence on the elimination of such wastes to the economic detriment of the community. In most of the foregoing situations, the planned dilution of the wastes involved, at general public expense, appears proper pending the development of economical methods of preventing or treating them.

In applying the above policy, it should, of course, be made certain that in no case is the pollutor thereby permitted to escape his responsibility where treatment or control is feasible. Neither should any pollutor be allowed to postpone provision of treatment facilities, when treatment is or becomes possible, because of the improvement in river water quality resulting from such planned low-flow augmentation.

It is frequently argued that even where treatment is economically and technically feasible, dilution could be substituted for such treatment if this is cheaper and if, at the same time, damage to the stream is in all respects satisfactorily prevented. Under these circumstances, the cost of providing the dilution water should, of course, be met by the pollutor, because he is thereby absolved from the necessity of constructing treatment facilities which he should, or would, otherwise have had to construct. Generally speaking, however, dilution is not considered equal to treatment because of possible dangers to esthetic and other public values associated with the use of a river for disposal of raw or partially treated wastes. Substitution of dilution for treatment is therefore considered contrary to public policy and, where permitted, should certainly be viewed only as an interim solution.

On this same question of permitting substitution of dilution for treatment, it is useful to observe, however, that project planning should be based on the concept of optimum utilization of dam sites and that, for this purpose, all possible uses for the waters which could be stored in a proposed reservoir site should be investigated. If, under these circumstances, economic studies should indicate a need for dilution water at a future date, a pollution source could, in the interim, use this dilution to permit a lower degree of acceptable treatment. Such substitution should be limited, however, to the period of time during which the water is not needed for higher priority uses. Present use of stored water for dilution should not grant a right in perpetuity. Also, it would appear proper under these conditions to require the pollutor to pay an appropriate amount for the dilution water as a substitute for the costs of the postponed treatment plant. In the present discussion, we are dealing primarily with those situations where a general pollution problem exists in spite of the provision of required waste treatment, and where dilution water as an additional pollution abatement measure for general public benefit, is provided at Federal expense.

Proposed Policy Regarding Use of Low-Flow Augmentation for Pollution Abatement. On the basis of the foregoing discussion, it is proposed that reimbursement for pollution abatement benefits resulting from low-flow augmentation from Federal reservoirs be based on the following policy:

1. Incidental pollution abatement benefits resulting from the operation of Federal projects for other purposes may be credited on a non-reimbursable basis to those projects, but such benefits should be computed for a limited time only, where projections of total future demands upon the stream for water for all purposes dictate the need for additional treatment in the future.

2. Where pollution abatement by means of low-flow augmentation is proposed as a non-reimbursable planned purpose of a Federal project, only those pollution abatement benefits should be credited to the project which would be produced after the pollutors have first provided efficient secondary treatment of their wastes, or if this is not possible because of the type of wastes, then treatment to the degree economically permitted by existing knowledge; provided however, that where secondary treatment or its equivalent will ultimately be provided but will require time to introduce, a specific phasing in period of time may be allowed during which credit for non-reimbursable benefits below secondary treatment levels may be claimed for the project.
3. In those situations where the concentration of pollutants to be discharged to the stream, as established by the state, is below the level which efficient secondary or equivalent treatment can provide, only those non-reimbursable benefits should be claimed for dilution water from Federal reservoirs which would be produced following efficient secondary treatment or its equivalent.
4. In those situations where different criteria for permissible pollution are set by different states on the same interstate stream, the most stringent of these criteria should be used as the datum above which non-reimbursable benefits for low-flow augmentation should be computed, because otherwise the pollutors in the state with the least stringent criteria would receive an unmerited benefit at the expense of the pollutors in the state with the higher standard. In no case, however, should the non-reimbursable benefits claimed be based on less than efficient secondary treatment or its equivalent.

Section II

Procedures for Evaluating Water Supply and Pollution Abatement Benefits

Difficulties in Measuring Benefits. The measurement of water supply and pollution abatement benefits derived from water stored in Federal reservoirs is rendered difficult by the varied nature of these benefits and by the absence of adequate economic tools for the purposes.

Municipal and industrial water supplies serve a wide variety of domestic and public purposes, including transportation of domestic and industrial wastes. The water provided enters into, but is only one of many ingredients in a great number of industrial and other processes. It promotes or preserves health, provides recreational, esthetic and other satisfactions of quite an extensive, but often quite an intangible nature, and otherwise plays a basic role in our whole life process.

It is generally agreed that the price paid for a water supply does not necessarily represent the value of the benefits derived from its use. Yet the true value of these benefits is difficult, if not impossible, to determine, because social as well as economic values are involved*, and no generally acceptable method of measuring them has yet been devised. Thus, arbitrary and admittedly inadequate methods must be relied upon for their determination. This condition is typical of all situations where the benefits involved are of a more or less intangible nature.

The abatement of pollution in a river by the release of stored water during low-flow periods prevents damage to the river by improving its quality as well as increasing its flow, thereby permitting it to perform more satisfactorily a number of functions which it could not otherwise do. Thus, the physical and esthetic appearance of the stream and its environment can be preserved or improved, fish and aquatic life supported, recreation enhanced, tastes and odors reduced, and dangers to health and damages to physical property greatly diminished. Excess costs of treating polluted waters for water supply purposes may also be prevented. Heat pollution may be dissipated by the lowering of river temperatures. In some cases, the benefits may, of course, be negative in character, that is, they may be detrimental to the river as in the case of oxygen deficient water released from the bottom levels of a reservoir.

Incidental benefits similar to the foregoing may also result from releases of water for other purposes, such as municipal or industrial water supply (where the stream is used as the transporting medium), navigation, flood control, or power generation.

Some of these various benefits from low-flow augmentation can be evaluated directly. For example, it is possible to determine the reduction in costs of treating waters withdrawn downstream, before use, as well as any reduction in the cost of treating wastes discharged to the river, made possible by the dilution. Potential pollution damages to river structures, boat hulls, engines, etc., can be computed. It may even be possible to evaluate the adverse effects of polluted waters upon the market value of abutting properties. But many of the damaging effects of pollution which are reduced or eliminated by dilution are difficult, if not impossible, to evaluate in monetary terms by existing methods. This is particularly true of damages to fishing, recreational pursuits, esthetic values, and environmental influences in general, where benefits can sometimes be described in quantitative terms such as numbers of persons served, pounds or numbers of fish caught or propagated, or other similar quantities, but cannot be reduced to dollars.

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* See addendum No. 1 on "An Approach to the Problem of Determining the Value of Water."

For those situations where dilution results in the elimination of the usual treatment facilities which would normally be required, the upper limit of the value of the benefits produced by the dilution would be the costs of the treatment plant eliminated. In those situations where dilution would still have been required, even after the treatment plant had been built, benefits in addition to those represented by the cost of the treatment plant eliminated must also be evaluated. These "excess" benefits would be computed in the same manner as those discussed below, where all reasonable treatment has been provided, but where dilution is still required to abate the pollution in the stream.

Presently Accepted Method of Assigning Values to Water Supply and Pollution Abatement Benefits. As indicated above, no satisfactory method has yet been devised for evaluating some of the described water supply and pollution abatement benefits provided by stored water, although many people feel that they far exceed the cost of acquiring the necessary water. In the absence of an acceptable technique for measuring them, these benefits have, for convenience, arbitrarily been equated equal to the cost of the cheapest feasible alternative means of achieving the same benefits, in the absence of the proposed project. Where a feasible alternative is cheaper than the project under study, it would, of course, normally be expected to be adopted in lieu of the project, or would in any case be considered the upper limit of the cost which the beneficiaries would be justified in paying for the project in question, as well as the arbitrary measure of the benefits to be derived from it. Thus, even if it were not necessary to assign a value to the benefits from a proposed Federal water storage project, it would still be necessary to explore all possible alternatives in order to determine whether the project is economically justified, and the arbitrary adoption, for mere convenience of handling, of some one alternative, to the exclusion of all others, is improper, unless it can be shown to be in fact the most economical practicable alternative available.

This arbitrary procedure for evaluating water supply and pollution abatement benefits is admittedly unsatisfactory and provides values which leave the investigator with the frustrating feeling that they may be very wide of the mark. In fact, it really does not solve the problem at all since it begs the question by flatly assuming that the benefits warrant the proposed expenditure in the first place. This position is justified, of course, in those reimbursable situations where the beneficiaries are prepared or are willing to pay the costs, since their willingness is a measure of the value in their eyes, but offers no solution to the problem where the costs are non-reimbursable, because it provides no basis for actual measurement of the values. Until such time as economists or sociologists can provide a more workable technique, however, we are pretty much stuck with this concept as the basis for the evaluation of these benefits.

Alternatives to be Studied in Evaluating a Water Storage Project. In the previous paragraphs, it was pointed out that both the limit on justifiable expenditure for, and the value of the benefits from a water storage project were, in the absence of any better procedure, taken to be equal to the cost of the cheapest feasible alternative method of achieving the same benefits in the absence of the project. Application of this concept makes it necessary to determine the alternative to be selected in each case, as the basis for measurement. The only limitation on the consideration of alternatives is that they must be true alternatives, which could in fact be built, and not hypothetical concepts devised merely for purposes of computation.

With respect to a municipal and industrial water supply project, the most obvious alternative is another water supply source. This may be a single purpose reservoir, either on some other stream, or at the site of the proposed project in its absence. It may also be ground water. However, in some instances, other alternatives are available, such as recycling or other conservation of the existing supply to extend its utility, or in the case of water for cooling, resort to cooling ponds or air cooling. All such alternatives should be explored and evaluated. In approaching this problem, cognizance should also be taken of the need for additional storage to provide additional water to dilute the wastes produced when a water supply is used.

Several types of alternatives are also available for measuring benefits from low-flow augmentation. As explained above, in those situations where dilution makes it possible to avoid construction of a primary or secondary treatment plant, the cost of such a plant is the most obvious alternative. Above the secondary treatment plant level, however, the practicability of further treatment must be taken into account, and other alternatives considered, such as (1) a single purpose storage reservoir which would provide the same amount of dilution water, either on the site of the proposed multiple purpose project in its absence, or elsewhere, whichever is cheapest; (2) tertiary treatment facilities, such as a super-treatment plant or a lagoon, which would achieve a reduction in the pollution load on the stream equal to that which would be accomplished by the proposed dilution; (3) other methods of dealing with the wastes in the first place in such manner as to prevent them from reaching the stream, or (4) other methods of providing the benefits which are produced by low-flow augmentation.

With respect to a possible super-treatment plant as an alternative, benefits must, of course, be computed on the basis of the entire cost of the plant, not on its rental value during the limited periods when treatment in excess of standard secondary treatment would be required, since there would be no other use for such a theoretical plant, and it would, of necessity, stand idle during those periods when dilution was not required.* The costs of such a plant should therefore include total capital outlays and interest and maintenance costs, plus those operating costs incurred during actual periods of operation.

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* See addendum No. 2 for additional discussion.

Closely akin to the super-treatment plant alternative is that of a tertiary stabilization lagoon or "polishing pond". This method may perhaps be much cheaper than the super-treatment plant, but there are serious drawbacks to be considered. These ponds require considerable space. Since most cities are located in or near a river bottom, there might not be room either for such a pond, or for the hydraulic head required for proper functioning without expensive pumping. In some locations the large areas of land required would also be costly. Furthermore, the delay caused by these lagoons in returning flows to the stream during dry weather periods when they are needed downstream might also be considered a damage since this waste water has value under these conditions.

A variant on the treatment lagoon concept is a simple storage lagoon, which would merely impound the treated waste water effluents until such time as the flood flows of the river are great enough to dilute these wastes without damage to the stream. Such storage lagoons might require less storage volume than the water required to dilute them, and could also be much deeper and of much less surface area than treatment lagoons, thus reducing evaporation and land costs. However, suitable sites would probably be difficult to find in river bottom areas. In addition to the drawbacks of space needs and hydraulic head mentioned above, this scheme also has the disadvantage of deliberately withholding water (even though polluted) from the stream at a time when its low dry weather flow might require that the additional water be made available.

In those situations where the purpose of dilution is to make possible the withdrawal of water further downstream for water supply purposes, the cost of an alternative source of water for these downstream supplies could serve as the basis for measuring the benefits from low-flow augmentation, and should be explored. In fact, if the alternative source of water supply is cheaper, it should be adopted, since dilution would then be uneconomical in the first place.

For those situations where a natural pollutant such as a chloride or sulphate may be too concentrated to permit use of the water for municipal and industrial purposes, but may not be detrimental to fish or recreation, dilution would appear to be uneconomical unless a demand either existed or was anticipated within the period of analysis, for such a water supply from the river. Also, it might be possible to divert such natural pollutants from the area of use, as an alternative.

With respect to recreational and similar benefits from a stream, which would be produced through dilution, the cost of providing similar benefits by alternate means should be explored. In many such situations there probably would be no apparent alternative facility, but a search in this direction for value measurements would seem to hold out possibilities as compared with the task of tackling recreational values directly.

In most cases above the secondary treatment level, perhaps the most practicable alternative for measuring the value of benefits from the project will be the alternative single-purpose storage reservoir which would be able to provide the same water supply as that provided by the project under study. All possible sites for such a reservoir should be investigated, including a reservoir on the project site in the absence of the project.

In computing the size and cost of the various alternatives, it will, of course, be necessary to undertake a careful operational study of the stream in question, based on hydrologic records, to determine the frequency, duration, and actual volumes of flows of the river during its low flow, as well as its flood stages. These data, coupled with the patterns of timing and concentration of waste water discharges to be expected, and the relative costs of correcting the situation under various assumptions regarding permissible stream damage, are used to indicate the volumes and durations of dilution water releases to be provided. Such a study will provide the basis for determining the total annual amount of dilution water to be released, and therefore, the storage space to be provided, or, in the case of super-treatment, the maximum treatment plant capacity to be provided. If a storage lagoon is envisioned, the frequency, magnitude, and duration of the flood flows during which the lagoon would be discharged, must be determined in order to determine the maximum waste storage volume required.

In making a comparison between the cost of the Federal project and that of an alternative, the procedure is usually complicated by the fact that most alternatives would usually be financed by non-Federal agencies over a shorter period of time, and at a different interest rate than the Federal project. Because of this fact, it is necessary to convert both costs to a common base for comparison. This is perhaps most easily done by reducing all costs to present worth. Thus, the total of both interest costs and of operation, maintenance and replacement costs for both the Federal project and the alternative would be reduced to present worth and added to the initial investment costs, to get a total figure in each case for comparison. It is also possible to make the comparison on an average annual cost basis by converting all figures to a common time period.

Addendum No. 1

The Problem of the Value of Water

A basic problem in determining the value of water stems from the concept that water is endowed with some fundamental intrinsic value which is inherent in its nature. This assumption is obviously fallacious. Water has many values, depending on location, condition and volume of supply and intended use. In any given location, water, regardless of the benefits and satisfactions it conveys to the user, is worth what it costs to get it, up to the point where cost exceeds the price purchasers (used here in the broadest social as well as commercial sense) are willing to pay. In the latter situation, price voluntarily paid represents the limit of its value, this limit often being dictated by nothing more than sheer judgment on the part of the purchaser.

The cost of acquiring a water supply for a particular use includes both direct costs and indirect or associated costs. These indirect costs include such things as benefits from other possible uses for the same water, which must be foregone or renounced, or detrimental affects on other following uses and users of the same water, for which compensatory measures must be provided. It is often difficult to measure these indirect costs. In many instances they represent social costs which are not reflected in the costs assigned to the water project. Some of these effects and interrelationships are discussed in following paragraphs.

A further difficulty in determining water value arises from a tendency to confuse costs with reimbursements, or with accounting items used in tax and rate making procedures. Costs represent expenditures (or benefits foregone), which must be made in order to acquire water. Reimbursements involve the question of who pays these costs - not necessarily the same people as the users. Accounting quantities used for tax or rate making purposes sometimes involve concepts other than or in addition to actual costs. These distinctions must be kept clearly in mind, since the determination of "who pays what" involves social and political as well as economic considerations.

Water serves many purposes - some of which are absolute in the sense that there are no alternatives to such uses. The most important of these is, of course, for domestic water supply - household use. In the most limited and narrow sense this means direct human and animal consumption of water. Other household uses such as for cooking and personal and household cleansing are second, followed by transportation of wastes, watering of gardens and lawns, washing of cars, etc., in some descending order of importance. For the first of these uses, water is worth whatever it costs to acquire, since life itself is at stake. Under these circumstances, the limit on value is equal to the total resources available to the people for the acquisition of water, since the only other choices are to move on to some more favorable location or to perish.

For all other uses, there usually are choices and alternatives which help to establish value, although these choices are not necessarily easy to make. Most domestic uses have to do with the quality of human living and environment, and benefits relate mainly to matters of human health or welfare. Cleanliness, sanitation, fire protection, and maintenance of gardens, lawns and parks all contribute not only to physical health and well-being, but to mental health, and to esthetic, social and cultural betterment, both on an individual and a community-wide basis. Such benefits are not as susceptible of monetary measurements as are benefits from uses of water for other more material (or commercial) purposes. Thus, where water is relatively plentiful, the value of water to be used for health and welfare purposes is largely a matter of the judgment or choice of the purchasers* with respect to the expenditures required to acquire the water, when compared with other types of benefits which might be secured from expenditure of the same funds for other purposes. In areas of inadequate economic resources or of low income, this choice, even where water is plentiful, will, however, be dictated largely by the demands upon scarce funds for more fundamental needs such as food, clothing and basic shelter.

On a community-wide basis, the choice is frequently affected by the attitude of citizens toward taxes or other public charges. Communities are often quoted as being unable to afford an addition to their water supply system, or a sewage treatment plant to clean up water after use. What these communities are really saying is that their citizens prefer to spend the additional sums involved for more chewing gum, gasoline, movies, or televisions, rather than for the extra taxes or service charges required to pay the costs of water for green lawns, clean streets, fire protection or more fishing in the river. This attitude arises largely because these water facilities or services are frequently not paid for directly by the citizen, and the relationship between the benefits and the payments is therefore tenuous, or the values to be derived from the extra water or the cleaner river are not directly comparable to chewing gum or a TV.

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* The term "purchaser" is used in the broadest sense and is not intended to be synonymous with the ultimate consumer. For public health, welfare and other public policy reasons, the purchaser can be and often is a public body which does not necessarily receive adequate compensation from the ultimate consumer, but elects to subsidize his use of water as a general public welfare policy. Here, again, the confusion which arises between costs and reimbursements must be kept clearly in mind.

The value of the water is nevertheless still based on a choice, dictated by the cultural pattern or the standard of living of the people of the community.

In arid areas, such choices tend to diminish or disappear, and the philosophy behind water use changes character, since a limited water supply would naturally be applied first to agriculture or other material productive effort, rather than to, say, watering lawns, a deferrable use in the face of more basic economic need.

With respect to most public uses of water, such as for recreational facilities, sport fish propagation, or the transportation of wastes, no precise monetary evaluation of benefits can usually be developed for comparison with costs or with benefits from other types of usages which can be so evaluated. A non-monetary, but nevertheless definite quantitative evaluation can often be made, however, numbers of people served per year, or numbers of pounds of fish raised or caught per year provide a guide. The choice is still largely one of judgment in the final analysis, however, because specific monetary benefits from possible alternative industrial or consumptive uses must be compared, from a broad public point of view, with the non-monetary general benefits from these public uses. (Even so, some of these latter uses can be shown to induce substantial secondary activities, which are measurable in money, such as stimulation of local employment, manufacture and sale of equipment, sale of food, gasoline, and other services, which might provide a basis for comparison with similar specific local benefits from commercial uses.)

Still another category of uses, which lie in a half world of susceptibility to comparative evaluation, is concerned with such uses as industrial or power plant cooling or generation of hydroelectric power, where the basic costs of development for such uses are comparatively low per unit of water involved. In these instances, the water is usually passed on to others for such other uses as municipal or industrial water supply, recreation, fish propagation or sewage effluent dilution, but is modified either in temperature, or time of availability, to such a degree as to materially reduce its suitability for these other uses. These detrimental effects, which are often not susceptible to monetary evaluation, must nevertheless be taken into account along with the direct monetary costs of developing the water supply for these commercial uses. Where the succeeding downstream uses are sufficiently important, public authorities may be faced with the necessity of determining whether the initial commercial uses shall be denied or additional costs imposed upon the commercial users for plant modification in order to reduce the detriments to these other downstream users. (Use of cooling towers, recycling and re-regulating reservoirs are examples of such plant modification.) With the imposition of these additional costs, the cost of the water may exceed the value to the prospective commercial users, who may then abandon their proposals to utilize it for cooling or power generation, or may adopt alternative methods of achieving their ends.

It is only when one gets away from the intangible field of domestic and community or other public uses involving problems of health and general public welfare, that it becomes possible to apply what may be called market values to water. There are choices, of course, but under these circumstances it can be assumed that the choice would normally be based on the greatest economic return. For example, it is entirely possible, in many instances, to determine on a comparative economic basis the production and employment returns from, say, irrigation versus navigation or industrial water use. Development of a water supply for an irrigation project of low yield might prove uneconomical, but might be justified for a recreational or an industrial development which provides sufficiently high returns to warrant the expenditure.

Within the area of industrial use, evaluation of a water supply in relation to cost would again depend on the alternative returns from various types of industries, some industries being unable to meet high costs, others being entirely able and willing to do so. Even in this situation, choice varies with location, since an industry may be unwilling or unable to meet high costs in one location, as in eastern steel mills, but may, because of a more favorable location with respect to markets, be prepared to pay higher costs either directly for the water, or for measures to conserve it - as in the case of the Fontana steel mill in California. Even this situation is not static. Eastern steel mills are unwilling to pay high costs for water only because of the existing plentiful supply. At some future time, other demands for water in these areas may make it so valuable that these mills would elect to install conservation measures rather than pay higher charges for the water.

As the competition for water increases with increasing population and the multiplication of uses, the cost of acquiring or providing water of suitable quality will gradually increase for various reasons. Correspondingly, the value of water will also increase, both because of increased costs and because of competition for scarce supplies. Thus, there may arrive a time when, for example, the cost to the public for the use of rivers as residual waste carriers (even after so-called "complete" treatment) in terms of detriments to other uses and users, such as water supply, recreation or fish culture, may be so great as to warrant a search for other methods of waste handling, or for more elaborate (even though more expensive) waste treatment facilities such as desalination of secondary treatment plant effluent.

The foregoing discussion and examples attempt to point out that each water use and development situation must be evaluated on its own particular merits and to demonstrate that no basic general value can be assigned to water per se, either with respect to place or time of occurrence or use. This does not mean that efforts should not be made to determine the value of water for any given use or circumstances. Such determinations are badly needed. But, even in specific situations, the determination of the economic and social value of water is difficult, and much work is required to develop suitable techniques and procedures for making such evaluations.

Addendum No. II

Computation of Alternative Treatment Plant Costs
as a Basis for Evaluating
Pollution Abatement Benefits from Low-Flow Augmentation

Suggestions have been made that the waste treatment cost figures developed for the use of the Senate Select Committee, as shown in Committee Prints 9 and 29, be used as the basis for computing the costs of treatment as an alternative to dilution. These figures are inadequate for this purpose. They were developed to indicate the total cost of providing normal standard treatment on a continuous basis in a river basin. Beyond this, Committee Print 29 had as its objective the determination of the volume of stream flow required to assimilate such treated wastes, on a basin wide basis, but did not attempt to evaluate the benefits which would result from such dilution. The Committee's problem and the one we are dealing with in attempting to place a benefit value on water provided for low-flow augmentation are two separate stages in the over-all problem of the management of water quality in a river.

The cost of treatment which would be required to achieve the same results as dilution after secondary treatment are far higher than the costs of standard secondary treatment, and are further complicated by the fact that such super treatment would only be required at spasmodic intervals when normal river flow falls below the point where the stream could assimilate the treated effluents. Thus, the super-treatment plant must be visualized as a standby plant constructed solely for this purpose, and standing idle during those times when the river flows were high enough to render use of the plant unnecessary. Under these circumstances, the cost of removing a unit of BOD by the super-treatment plant must be computed by charging out the entire capital cost of the standby plant against this spasmodic service and would thus be far higher than that derived from the figures contained in the Committee print.

DISCUSSION

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I am sure there is no question on the need for the development of a set of principles and policies for low-flow augmentation from Federal water storage projects for pollution abatement.

Low flow is being recognized more and more as one of the important factors that must be considered in water management planning. The Congressional viewpoint is reflected in S. 120, Senator Kerr's bill, in which it is proposed that Federal agencies contemplating initiation of planning for reservoir or other water impoundments notify the Surgeon General, who shall, in those cases where it would promote water pollution control, recommend storage needs, flow regulation and other water quality control features necessary.

The bill further provides that ". . . it is the intent of Congress that benefits resulting from water quality control features incorporated in any Federal reservoir or other impoundment under provisions of this act shall be evaluated and the beneficiaries determined, and if benefits are widespread or national in scope or if the principal beneficiary is the general public in the area, the costs of such features should be non-reimbursable."

I personally am convinced that in the near future we will have legislation incorporating low-flow augmentation for pollution abatement in Federal reservoir projects. It is obvious that the Division feels the same way and supports such legislation, or Mel would not have expended so much time and effort in developing the position paper just presented.

Before going any further, I would like to call your attention to a significant fact about Mel's paper. It is still classified as a "draft" and I suspect if we were to associate a number with it, it would be at least the third. Regardless of the number assigned, it is the draft in which Mel has attempted to satisfy all the comments, criticisms, and objections we raised on the original draft.

The fact that this is still looked upon as a draft indicates that it is still in the development stages and that we have another opportunity here today to air our feelings. It is hoped that we can confine our discussions to the basic principles and policy issues rather than become involved in word changes.

I know that Mel would be more than happy if we could reach agreement in basic concept areas. These are: *First, can dilution be considered equivalent to treatment?* The paper says *no*. It does not consider dilution as a substitute for treatment, but looks upon it rather as a supplement to a program of treatment and ultimate removal.

The paper points to Mark Hollis' statement before the Committee on Public Works, in which he said, "We, therefore, suggest that the record be clear that low-flow augmentation should not be used as a substitute for sewage treatment works required by state authority or comtemplated in comprehensive pollution control plans under the Federal Act."

It would appear, therefore, that we have already established a position in this area. However, there are other views which consider such a position as too narrow and limiting in that it has as an ultimate objective the complete elimination of waste from entering streams without regard for the assimilative capacity of the stream. Others hold that the only logical approach to the problem is to first determine the desirable water quality objectives for the stream, and then consider all alternate ways in meeting these objectives, including dilution along or in combination with treatment and selecting the most economical. You will recall the first question raised in this conference, and the answer to which was deferred until this time, was, "Why should dilution not be considered a solution to pollution?" I mention these various viewpoints merely to show that this is an area which is by no means clear-cut.

The second basic concept area in which there is need for agreement one way or the other is: Whether secondary treatment is a proper cut-off point in assigning non-reimbursable benefits for low-flow augmentation. The paper is based upon the concept that secondary treatment is the proper cut-off point. I myself would consider this as reasonable. Certainly, as a tax-payer, I would take a dim view toward contributing to pollution abatement through low-flow augmentation until all reasonable corrective measures had been taken by the polluter.

Here again, however, we are not in an area that is clear-cut. There are those who will argue that there is little logic for justifying non-reimbursable flow augmentation beyond the secondary treatment level if not justified otherwise and, therefore, why not assess the polluter all social costs.

If we can come to some agreement on the two above mentioned concepts, we will have in effect agreed on a policy regarding the use of low-flow augmentation for pollution abatement.

Only one other basic concept area remains which requires some degree of agreement. This relates to the second section of the paper, and is concerned with procedures for evaluating water supply and pollution abatement benefits.

In developing such procedures, Mel applies the concept that in the absence of a more satisfactory method, the value of the benefits from a water storage project are taken to be equal to the cost of the cheapest feasible alternative method of achieving the same benefits in the absence of the project.

In our Title III water supply projects, we use just such techniques. With respect to pollution abatement benefits, it has been suggested that these evaluations can be greatly simplified by determining the increased assimilative capacity due to low-flow augmentation - equating this to BOD and calculating the value of the benefit as the cost of removing an equivalent amount of BOD per day in a treatment facility. Similar reasoning would apply to other types of waste constituents.

Here again, this area of procedures for evaluating benefits is far from clear-cut and is worthy of much discussion. Discussion, I hope, will include consideration of parameters other than the old stand by, BOD.

The above has been an attempt to very briefly point up the basic concept areas in which we must reach agreement. Being an optimist, I believe we can reach such agreement here today. Following agreement on these three basic concepts, I would like to suggest that we consider, one at a time, the five tenets set forth at the beginning of the paper, and the four recommendations set forth on pages 235 and 236.

GENERAL DISCUSSION

TORGET: I don't know how well I can express myself here but Jim Flannery made a statement that we should be careful not to give unqualified endorsement to recommending a spotless river, and Bob Haywood and Jerry gave some examples of this. Now, then, Mel spelled out a very excellent framework that we can stand on. I'm sure there may be some modification, but it's still the beginning of what I consider a very excellent framework. We need this. The alternative is to get us in a position where we are going to endorse pork barreling, and this, I think will certainly damage the prestige of the Public Health Service. I worked with an agency for three years and their analysis was a little bit loose. They didn't consider the negative benefits and this sort of thing, and frankly, when they sat before Congress, the Congressmen folded their hands and said, "Now let's watch the malarkey fly." We have high prestige - we haven't damaged it yet. And Mel's suggestion here, I think - it should be pursued and we should have solid ground on which to stand, lest we just plain lose the high stock that we have now in the whole organization.

DWORSKY: I feel that I should stand up and say I agree nearly completely with Mel. I think it's important - terribly important - that we undertake the action he suggested here in order to bring some concensus of this group to bear on Mel's proposals. I think we ought to do this without worrying too much about the time, because I think here we have a paper that provides us what I think Jerry and Bob had asked us to come here for essentially - to bring the minds of this group to bear on those things which can be specific, and in this paper we have some most specific proposals. I would hope that time wouldn't be the factor in determining how long we take to discuss this matter, and ought to reach some concensus on the points raised.

GEBHARD: There's no apparent argument here. I'd like to again suggest so that we can get the record straight on this, that perhaps this is the time to go through, one by one, these proposals that were set forth by Mel. First, the basic concepts on which he has set up the paper, and then going over to his proposed policy and checking through one by one those four paragraphs which make up the proposed policy.

SCHEIDT: Let me urge that we not spend too much time on precision and nit picking but do we agree with the substance of what is being said, because I'm pretty good at nit picking, myself. I can correct the small refinements in actual language. Item 1 of the tenets on which the paper is founded says that primary effort in pollution abatement should be toward the reduction or elimination of polluting wastes at the source, by means of waste treatment plants or other means. It says "primary effort." That isn't an absolute, but it recognizes the fact - there would be other means - but primarily this is what we ought to demand.

POSTON: Is there total agreement in this? It looks like it's unanimous after a show of hands.

SCHEIDT: Other things being equal, dilution should not be considered a substitute for waste removal, but should be looked upon rather as a supplement to treatment and ultimate removal. In the latter sense provision of dilution water should be considered a secondary defense - an interim measure - to be resorted to on a temporary basis pending the time when better treatment methods can be developed.

KLASHMAN: Our whole policy has always been that the type of treatment needed was that required by the highest legitimate use - and we always have accepted dilution in lieu of secondary treatment. Your statement, Mel, seems to be getting away from this concept. Is not this so?

SCHEIDT: Yes.

KLASHMAN: Until we get to the time that you can really assess and evaluate this benefit, we can accept Mel's philosophy.

POSTON: Leonard?

DWORSKY: Let's just read this again carefully, because I think even Mel extended his point here a little bit. I believe he said dilution is not a substitute for waste removal, but should be looked upon rather as a supplement to a program of treatment and ultimate removal. Now this doesn't say here that you're committing yourself to secondary treatment as such. And if you did, I'd agree with you - but I don't think you say that here.

SCHEIDT: Not yet.

DWORSKY: "In the latter sense, provision of dilution water should be considered a secondary defense, an interim measure to be resorted to on a temporary basis pending the time when better treatment methods can be developed." Now here again, you didn't say anything about clearly knowing that secondary treatment is your basic aim. I raise the point, Les, because I think you imply that he meant secondary treatment. I only want to deal with the words that are said here.

KLASHMAN: This is what he means.

SCHEIDT: Secondary treatment doesn't necessarily apply in there.

DWORSKY: Taking this point only for what it says here, I would suggest that we accept it, because I think that this represents the current status of the program development of the pollution control program in the Federal government, and certainly in Public Health Service. I think that this represents the long term historical position as we now have reached to this stage. I think anything less than this is untenable. I think that we simply must take this position.

POSTON: Dick Vanderhoof.

VANDERHOOF: Well, I certainly would agree with the concept that dilution is not a substitute for waste treatment, but I have over the past and probably will in the future, unless I'm stopped right here, use this method as a tool - a very poor tool, I admit, of setting a value on water. I know very well that the cost of treatment is much less than the cost of developing a unit of water, and any value that I come up with for a unit of water is of necessity very conservative, because I have worked with the old tool of the BOD, and I know that this is not the only parameter. I have had much soul searching trying to develop other parameters to set a value of one unit of anything else that you might be able to reduce by dilution, for instance, as a waste. Dilution of something which is not treatable - insecticides, maybe, pesticides - but to get back to the BOD, I certainly will admit that this is one of the few tools that I have to work with, and it is an approach to a value of water, but it certainly is limited, I admit.

HAGER: Reading what it says here, dilution is not a substitute for waste removal. This was mentioned the first day of the session - this thesis that Tom Camp brings up in relation to a specific type of waste that's not removable. He suggests grinding the sewage up so that it neither floats nor settles but is carries on pretty much, and then socking it with chlorine. Where does this fit in, Mel? This isn't removal.

SCHEIDT: No. From the paper that I have tried to write here, merely grinding sewage up and putting a lot of chlorine in it is no substitute whatever for removing it. I don't think there's any answer to that one, except that that is not treatment. That isn't acceptable under this concept.

REED: I think we're mixing up a point here. We aren't trying to determine whether this is an acceptable method of treatment. I think the point is that if this is not satisfactory, are we going to put water in a stream on low-flow augmentation to allow him to continue this, rather than to build treatment facilities - and I wholeheartedly agree with the philosophy that if his solution is not satisfactory, we don't put in water at Federal expenses to allow him to continue. I agree with Gebhard and some of the other philosophies here, that if, as a taxpayer he says he would object, I think I would, too.

THOMAN: Some place in this thing, I think that we should have this question of reasonable use resolved. It seems to me if that statement were changed, or some of it were deleted in this fashion - dilution is no substitute for waste removal but should be looked upon rather as a supplement to a program of treatment - period. And just stop there. I think we might get the sense of what everybody's thinking.

SCHEIDT: I'm perfectly satisfied with that.

THOMAN: It implies that you're taking into consideration the reasonable use of water downstream.

SCHEIDT: I think as a matter of fact it strengthens it, Jack, by making it shorter.

POSTON: All right, read this, and then we'll have our vote, as amended.

SCHEIDT: Dilution should not be viewed as a substitute for waste removal, but should be looked upon rather as a supplement to a program of treatment.

POSTON: How many could buy that?

FROM AUDIENCE: Adequate treatment?

SCHEIDT: Dilution is not a substitute . . .

SVORE: That weakens it, Mel.

SCHEIDT: Dilution is not a substitute for waste removal, but should be looked upon rather as a supplement to a program of adequate treatment. Put a period after treatment in the third line and leave all the rest off. The rest is just window dressing, anyway.

POSTON: Now let's have a show of hands - those of you who would go along with this.

Let's see those who would not. Schreeder? I admire you, here.

FLANNERY: I don't dissent, here. I'm not sure what you've said says anything, so you're not obligated to face the question.

SCHEIDT: This is only one of the tenets on which the rest of the paper is based.

FLANNERY: Are you specifically applying the question as to when will the Federal government provide storage for low-flow purposes? Is the Federal government going to provide this free, not reimbursable, only when it would supplement beyond secondary treatment? If that is the question you're trying to answer, why don't you say it flat, and say so? Bring in, in other words, Bill Davis' paper.

SCHEIDT: I'm not sure I get what your're getting at.

FLANNERY: I think you're being evasive on this point.

CLARE: Are you suggesting he substitute secondary instead of adequate?

FLANNERY: Yes. Use the term.

GEBHARD: In number 3, if you go to the other page, I think you'll find that . . .

FLANNERY: Why did you do this one? Three will . . .

SCHEIDT: Jim, I don't know whether I've made myself clear or not, but I simply tried to set down certain basic principles at the beginning of the paper on which I would found arguments to arrive at specific conclusions. At the time we arrive at specific conclusions on page 11, we do say flatly that the Federal government will not provide dilution water for free unless secondary treatment has been provided.

SVORE: And the time element is involved.

POSTON: Let's move on to number 3.

SCHEIDT: The costs of waste treatment or removal should rest first with those producing the wastes but beyond this, the cost of storing dilution water producing widespread benefits should be non-reimbursable.

POSTON: Comments? How many are in favor? Hold up your hands. How many cannot go along with it? (I think there are some who have refrained from voting.)

SCHEIDT: Item 4 - in providing storage for a water supply, the necessity of providing additional water for the dilution of the resulting treated waste effluents should be recognized. This is the principle we are following in the studies down here now.

POSTON: Comments? How many are in favor - show of hands.

GEBHARD: I'd like to know what the question was that was raised. I'm wondering about the definition of water supply - domestic?

POSTON: Anybody opposed to this?

SCHEIDT: Item 5 - in developing Federal reservoir sites, every effort should be made to conserve their full potentialities through development of optimum storage capacity. Now I'm not sure whether we want to buy this fully just as I stated, or not, because as I said on the floor the other day, I am more concerned that the conservation of that site be insured rather than the full development take place now. The important part is, that when and if you need the full storage capacity of a reservoir site, it will be there for you. I would not advocate myself the wasteful expenditure of money now for additional storage of such huge volumes that it might be 50 or 75 years before they get to need it.

KLASHMAN: Would you define what you mean by optimum? You do not mean maximum?

SCHEIDT: Optimum would mean the most economical beneficial use resulting from the reservoir. If you develop a reservoir so large that your evaporation begins to diminish your total ultimate amount of water producible, then you haven't got the best development of that site. You've got the maximum possible storage capacity, but you haven't get the optimum beneficial development.

SVORE: I wonder if the word you're looking for is "optimum yield" instead of capacity. You're really not interested in the capacity.

SCHEIDT: Very good.

KLASHMAN: I think he means by optimum, I think he means the best reservoir you want in terms of use, rather than yield.

THOMAN: I think it would solve the whole argument by saying "developing Federal reservoir sites to conserve their full potentialities" - period.

FLANNERY: Does this mean - are you going to talk about every water use of a reservoir, even though power, storage, for instance . . .

SCHEIDT: No. We've got to leave that to the other agencies.

FLANNERY: This statement doesn't limit it to anything. It takes in everything. We're dealing beyond our realm.

SCHEIDT: Within the concepts of comprehensive pollution abatement programs that we are beginning to work at, we're going to have to face the fact that we'll have to urge the other agencies who have a vested interest in the rivers to come forth with their needs, too, and in that sense I think we do have a responsibility, at least, to bring to the attention of all the other users the necessity of participating with us in the optimum planning for the reservoir.

FLANNERY: You ought to have a preface on there. I suggest at the beginning of these several points referring to either the Act, or the Public Health Service responsibility. You should say so at the beginning.

SCHEIDT: What we do say at the beginning - I don't know whether it's the proper place - we say this paper deals with the problems associated with evaluating and paying for the benefits derived from the use of water stored in Federal reservoirs for those purposes which are the concern of the Public Health Service.

FLANNERY: But you haven't put that preamble when you're voting on these points. Now this panel isn't going to become a gospel reference. Get it down here as a basis for the discussion of these problems.

SCHEIDT: What would you suggest, Jim? Be specific.

FLANNERY: You know I don't have a propensity for words, so I leave that with you.

DWORSKY: I'm not sure we ought not take a position on this matter of Federal reservoir sites. I think that we have as much a right to a position as anybody else in this country of ours, and people all over are taking a position. Now I think the items preceding this are largely the Public Health Service's direct responsibilities, but I see no reason why we shouldn't take a position in this, too. I see some problems in taking the words "maximum" and "optimum" depending on other factors, but I think the words "optimum development" couldn't be too far out of line, and I can't argue with the ultimate decision. You can't do that.

FLANNERY: I'm not interested in optimum-maximum. But on this point I would say this could be interpreted to mean that we have to get into this public power argument which would only be troublesome, without any gain. Why invite the trouble?

DWORSKY: The Kerr Committee and others - new policies to indicate site development ought to be at a pretty high level and considered for all its values.

FLANNERY: I think that invites trouble. I think you should stay within the Public Health Service realm. When you wander beyond that, you're in a fight to see how big your muscles are.

SVORE: I'm inclined to agree with you, Jim. I think if we believe in water quality, we ought to say so. And if we think that water quality is down at the bottom of the totem pole, we shouldn't be in this business. I think in the future if we can look down the road far enough, we're going to find out that water quality is taking precedence over power, navigation, irrigation - over a lot of other things that it has not had precedence over to the present time. Now we believe this - then I think we ought to say it. Is this your point, Jim?

POSTON: Do you have a particular way you want to say this?

THOMAN: I think I've got that. In developing Federal reservoir sites every effort should be made to conserve their full potentialities through water quality management.

SCHEIDT: That isn't what I mean at all. Maybe what I mean is not something you've prepared to vote on. I am concerned with the fact that when you build a reservoir, that reservoir is fixed for a long time to come. It has multiple purposes, yes, but it has a certain storage capacity. Now I recognize that there are variations in the amount of storage that you ought - in association with other reservoirs on the river - actually to develop. But within some framework of computation on a total basin basis, that particular site has a certain optimum development which in association with all the other reservoirs will permit the total river basin system to serve to the maximum degree possible the various uses that river basin will in the future be called upon to serve.

SVORE: As long as it doesn't interfere with quality.

SCHEIDT: Quality is inherent in the total water basin development. This is basic. I am assuming that we all are agreed without having to argue about it here that the concept of river basin planning includes the concept of water quality management - that it includes all that is implied in the directive in Section II of the Act - that comprehensive pollution abatement programs must, of necessity, face up to and include and solicit the cooperation of all other agencies that have anything to do with the river. And the comprehensive program when we're through with it will be in fact a blueprint for the river for all purposes. Else you can't have a satisfactory pollution abatement program that means anything in the long run for long range development. Under the circumstances then, what I'm trying to say here is that we should try to promote the concern for the conservation and the potentialities in a reservoir site within such knowledge and wisdom as we now have available to us to the maximum degree possible, because once the site is usurped and development allowed to occur around it - railroads, highways, towns, villages, recreational development - the cost involved in enlarging that site, if at some future time you need to enlarge it to maximum, or optimum development is then going to be prohibitive, and I am concerned here only that we take such measures as are necessary to see to it that this site is not usurped or encroached upon pending the time that we have to develop to its fullest.

POSTON: Do we have a revised statement here, Mel?

ALEXANDER: Is it intended that these policies and principles will be enunciated in its full form as it's given here, or are they going to be developed from something that is extracted from this paper?

KRAUSE: I think its usefulness will be that of something like a recommendation from an assemblage of very definitely interested persons to those of us who may have to write these things down. We want to get what you're thinking here, and we want to get it as it represents a majority principle here. Now I won't go so far as to say what we're saying here today will suddenly appear as a written policy to the Public Health Service, but what I would hope we could do is to utilize the talents of our industry and thinking that's gone into these problems from you fellows to either support or tell us we're getting out of line in producing these policies. Most of this stuff is not just policy - some of it's getting awfully close to where it has to be a policy - but in effect we look at this as a recommendation of a group such as yourselves coming, if you will, as representative of - and maybe because of some other reason which I don't know anything about at the moment - we would have to inject or reject in its entirety the things that you're doing today. But I don't think this is apt to happen. So the thinking about this is extremely important, and if there is marked disagreement, certainly it necessitates reconsideration on our part on these things. If there's definite feeling for these things, then only other considerations which may not at the moment appear on the horizon would probably change them, but it's this kind of a thing that we're engaged in here right now. And what you tell us may very well be the policy. On the other hand, there may be some things which we cannot evaluate here today which will exert their influence and make it necessary that some of these things be changed somewhat from the picture which you may - as we collectively need as policy for Public Health Service.

SVORE: I have a suggestion to make. I wasn't arguing against what you said here, Mel, and I agree with this. I felt though, that you were not waving our flag in saying this with its proper perspective. Maybe we could change it along this line to bring out that point. In developing Federal reservoir sites, every effort should be made to conserve their full potentialities through optimum developments which take fully into consideration the water quality aspects.

ALEXANDER: If the first paragraph of this introduction would be included, doesn't this answer all of the objections?

SVORE: It includes this, but I'm trying to get Flannery's point in here. As he said before, it ought to be said here too.

NOBE: Mel, it seems to me that you have something left implied which is not in these tenets. In a sense what you're saying - you said it orally a minute ago - that you consider that water quality management is an integral part of the comprehensive planning, and I think it's left implied, but not specifically stated that in that sense quantity and quality are not separate components, and I would like to see somehow this made stronger in these tenets.

SCHEIDT: This suggests a sixth tenet, then. Could I ask you to put that in words? If everyone has agreed here with the substance of what you said, can I ask you to give me the actual wording that might go in that?

NOBE: Quote: "Water quality management is an integral part of the concept of planning for comprehensive river basin development. In this sense quantity and quality are inseparable components of this procedure."

SCHEIDT: I would put that in ahead of this one - of number 5 - and then make this one 6. I think we're running into the danger here of getting over into the discussion of the whole problem of comprehensive pollution abatement programs for river basins. While I would hope that we would have a three day conference on this very subject, I'm afraid we won't have time today to discuss the whole subject. Now have I misinterpreted what we're getting at?

DWORSKY: I suggest we move on Jerry's motion.

POSTON: All right - 5 and 6 tenets here and see whether there's agreement.

SCHEIDT: Ken Nobe read his. I accept it as he read it. It was before you, so let's take that one before we take 6. That will be introduced as a new number 5.

> Mr. Nobe wrote his proposal on the blackboard, which read: "Water quality management is an integral part of the concept of planning for comprehensive river basin development; in this sense quantity and quality are inseparable components."

Item 6 is now "In developing Federal reservoir sites, every effort should be made to conserve their full potentialities through optimum development which takes fully into account water quality aspects."

THOMAN: I'd still like to go back to take care of water quality management. Let's put a period after "potentialities".

SCHEIDT: I'm satisfied. It will read "In developing Federal reservoir sites, every effort should be made to conserve their full potentialities for optimum development."

KITTRELL: How about inserting "optimum multipurpose development"?

SCHEIDT: That is implied.

POSTON: Let's have a vote on this, now.

KLASHMAN: Which one? We already passed it with "potentialities" - period.

POSTON: No, we didn't.

SCHEIDT: In developing Federal reservoir sites every effort should be made to conserve their full potentialities for optimum development.

POSTON: All right, raise your hands if you're in favor of this. Those not in favor?

KLASHMAN: Can't we vote against one or the other?

POSTON: No.

SCHEIDT: Geb suggested that we do the same thing with the items of the proposed policy enunciated on page 235 of the text you have before you.

SVORE: I'm wondering if we should go on to Davis' paper before we get involved in this. I'm considering what's in Davis' paper.

SCHEIDT: I think we can take the whole bunch of them say generally agreed principles, or we can find out where there are detailed objections.

POSTON: Let's read these in toto.

SCHEIDT: Having gone through all the previous arguments then we come out in this paper with a proposed policy regarding use of low-flow augmentation for pollution abatement. We say,"On the basis of the foregoing discussion it is proposed that reimbursement for pollution abatement benefits resulting from low-flow augmentation from Federal reservoirs be based on the following policy:

1. Incidental pollution abatement benefits resulting from the operation of Federal projects for other purposes may be credited on a non-reimbursable basis to those projects even though construction of treatment facilities which would otherwise be required is thereby postponed, but such benefits should be computed for a limited time only based upon a projection of total future demands upon the stream for water for all purposes.

2. Where pollution abatement by means of low-flow augmentation is proposed as a non-reimbursable planned purpose of a Federal project, only those pollution

abatement benefits should be credited to the project which would be produced after the pollutors have first provided efficient secondary treatment of their wastes, or if this is not possible because of the type of wastes, then treatment to the degree economically permitted by existing knowledge, " (I parenthetically put in that there might be no treatment at all, if there is no treatment available at economical costs), "provided, however, that where secondary treatment or its equivalent will ultimately be provided but will require time to introduce, a specific phasing in period of time may be allowed during which credit for non-reimbursable benefits below secondary treatment levels may be claimed for the project.

3. In those situations where the degree of reduction of BOD or other pollution to be achieved by treatment or the minimum oxygen level or concentration of pollutants to be permitted in the stream as established by the state is below the level which efficient secondary or equivalent treatment can provide, only those non-reimbursable benefits should be claimed for dilution water from Federal reservoirs which would be produced following efficient secondary treatment or its equivalent.

4. In those situations where different criteria for permissible pollution are set by different states on the same interstate stream, the most stringent of these criteria," (I changed the wording a little here), "should be used as the datum above which non-reimbursable benefits for low-flow augmentation should be computed, because otherwise the pollutors in the state with the least stringent criteria would receive an unmerited benefit at the expense of the state with the higher standard. In no case, however, should the non-reimbursable benefits claimed be based on less than efficient secondary treatment or its equivalent."

POSTON: Can we have any comments preliminary to a vote on this as to whether we will accept this in general?

VANDERHOOF: Mel, would there be a difference in the computation of Item 1 and Item 2.?

SCHEIDT: Item 1, Dick, would cover all of those situations where incidental benefits would occur even including, if you will, the elimination of primary treatment, if that happens to occur - if the state would permit it. In the case of Item 2, no benefits would be allowed for any substitution below the secondary treatment level. It's quite conceivable that under Item 1 as an incidental benefit since the stream is going to be regulated in that fashion no matter what happens - whether there is or isn't polluting on there. As a result of this a state relaxes with respect to the assistance on treatment below the secondary level, I think it's perfectly proper for the Federal government to take credit for it. Now we don't like it, we don't agree . . .

DE FALCO: Isn't this in essence a contradiction of our first point that we just reached?

SCHEIDT: Yes, it is, and it's a recognition of the political facts of life with respect to this situation, Paul. This is the result of comments that have come in to me from all over the country and recognition of the fact that this is the kind of thing that is in fact likely to happen, and also in conversation with the Corps of Engineers and other people. And actually, as a matter of fact, I gather from the practices that you fellows are following in dealing with the Corps in those situations where you're called on to evaluate the benefits resulting from the reservoir construction, which would, as an incidental by-product of doing other things, achieve a low-flow augmentation not intended for pollution abatement but which nevertheless does in fact accomplish pollution abatement.

GEBHARD: Doesn't this in essence say that where we could not before accept a credit in the cost benefit ratio, we now can recognize and accept it - put it in the formula and perhaps get a project going?

SCHEIDT: Yes, well, in any case where you're called on by the Corps of Engineers, whether they put it in the BC ratio or not, this would be a basis for giving them a value.

CLARE: On number 3, I would like to suggest changing the first part to read as follows: "In those situations where the concentration of pollutants to be discharged to the stream as established by the state," and so forth. This puts it on an effluent basis and does not mention any specific criteria.

SCHEIDT: "In those situations where the degree of concentration of pollutants to be discharged to the stream" . . .?

CLARE: "In those situations where the concentration of pollutants to be discharged to the stream" . . .

SCHEIDT: Where would you pick up from there? "As established by the state"?

CLARE: Yes, the rest of it is all right. That's the only change I have.

SCHEIDT: I won't fuss about that. Yeah, that's all right.

DE FALCO: Mel, I grant you the political concept. We have to live with it. But don't we, by putting in number 1 without qualifying it at least to secondary treatment, contradict the whole concept here? Don't we jeopardize our policy position?

SCHEIDT: Some.

DE FALCO: Why should we? Aren't we big enough to stand on our own policy?

SCHEIDT: I'm simply trying to reflect what you fellows are sending in to me. I agree. If you want to strengthen it, I have no objection to it, if you think you can live with it.

OWNBEY: It seems to me that as a statement of policy this whole section spells out entirely too many specific details. For example, we have found places where we are convinced that it will be much cheaper to build lagoons in addition to secondary treatment than it is to provide dilution water somewhere.

SCHEIDT: That comes under evaluation of the second section, Ray.

OWNBEY: But you say the secondary treatment limits, beyond secondary treatment. Well, it might be a great deal cheaper to go beyond secondary treatment with further treatment. And, of course, the state and local people would like to have dilution if it's a Federal expense and the lagoon would be at local expense.

SCHEIDT: In the second section we have said if tertiary treatment is cheaper than dilution it should be adopted. We specifically say that in the second section where we come to evaluation.

OWNBEY: Did I misunderstand you? Is this whole part here concerned with the incidental benefits?

SCHEIDT: No, this is concerned with both incidental benefits and direct benefits, but it is the basis for determining the policy under which we will assign values to the Federal reservoir. This does not concern itself with how we measure those values. The second part does that. We're only saying in this part that we will attribute values or benefits to the Federal reservoir under certain conditions.

OWNBEY: Then you're saying it would be non-reimbursable and would be provided at Federal expense provided this is cheaper than the alternative, is that it?

SCHEIDT: No, not necessarily. We're saying the cost of the alternative - that would be the upper limit of the value that we would place on it. We have no way of saying whether or not we would insist on tertiary treatment. This is a matter for state policy. All we're saying is that we will not go below secondary treatment as a basis for non-reimbursable evaluation.

SVORE: I still think if we vote on this now, there's no need to have the next paper. It seems like we ought to get back to this. Now we've talked about whether or not the Public Health Service ought to make secondary treatment mandatory.

SCHEIDT: Let's wait, then.

SHOULD THE PUBLIC HEALTH SERVICE TAKE A STAND AND MAKE SECONDARY TREATMENT MANDATORY?

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Let's take a stroll down the streets of Edinburgh in jolly old England about a century ago. The cobblestone streets, the quaint dress of the passers-by, the building architecture, and store fronts with manuscript signs soon give us the "plum-pudding" atmosphere of a Dickens' novel. Suddenly, the folks around us look panicky and head for cover, for the words "GARDY-LOO!" have been sounded by a housemaid's voice above us. Just as the word "FORE" means take cover on the golf course, the words "gardy-loo" were the maid's warning that she was throwing the contents of the night soil pot out of the window. Having hesitated too long to take cover, we are quite happy to return to the present day, where the words "gardy-loo" no longer rend the air with shattering impact.

Modern sewerage systems have made the words "gardy-loo" obsolete; by connecting each household, hotel, hospital, and industry with a sewer, the noxious, bacteria-laden, and potentially poisonous wastes of a community are no longer a sidewalk hazard. Instead, they flow swiftly and silently to the nearest water course - where, without even the courtesy of the warning words "gardy-loo" they are often thrown into the water plant intake of a downstream community. More than warning words are needed, however; the sewage must be treated and purified - but by whom? - the city where the wastes originated? - the receiving stream? - or by the downstream water plant operator? Only the factor of economics prevents unanimous agreement that purification should take place at the point of origin.

The word "only" was used not in the sense of minimizing the importance of economics but to signify that it is the one reason that prevents 100 per cent purification of waste water by all water users. There is a price tag on every gallon of waste water, from the time it is flushed from the user's premises until it is used again, or reaches the sea. Sewers and interceptors are not free; treatment costs increase with each per cent removal of waste-water ingredient; degradation of the stream costs a segment of society their health, recreation, and welfare; and it costs the downstream user not only the price of an elaborate water treatment plant with alert operators and high dosages of chlorine but a sword of Damocles that hangs constantly over their heads in the form of a threat of virus, untreatable toxic materials, and the potential malfunction of the human or mechanical operation of their water-treatment plant.

Until 1948, the Public Health Service had done little more than sound the "gardy-loo" warning for the stream polluters. It had recognized and sanctioned dilution as a money-saving substitute for waste treatment as long as there was sufficient water in the stream to "assimilate" the wastes. Except for PWA-WPA projects, Federal financial assistance was offered for neither waste nor water treatment; individual treatment plants were the responsibility of water users and their respective state health departments. It is interesting to note that today the Public Health Service has taken a stand and is granting financial assistance for the construction of sewage treatment plants but not for dilution water nor water treatment plants. Let's go back to the year 1948 and see how this came about.

In that year, the Senate Committee on Public Works (Report No. 462, 80th Congress) summarized the national problem:

> "Water pollution has become a matter of grave concern in many areas, and its damaging effects of the public health and natural resources are a matter of definite Federal concern as a menace to national welfare. Abatement must be undertaken to control it."

The committee report then stated the Federal responsibility in solving the problem: "The Federal Government should take the initiative in developing comprehensive plans for the solution of water pollution problems in cooperation with the states."

As a result of the committee's findings, the Taft-Barkley bill, Public Law 845, was passed by the 80th Congress. This bill was the Nation's first Water Pollution Control Act and put the Public Health Service in the business of water pollution control by specifying the responsibilities of the Surgeon General:

> "The Surgeon General shall, after careful investigation, and in cooperation with other Federal agencies, with State water pollution agencies and interstate agencies, and with municipalities and industries involved, prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. In the development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural, industrial, and other legitimate uses ...."

The bill also instructed the Surgeon General to encourage interstate compacts for the prevention and abatement of pollution, to support and aid technical research to devise and perfect methods of treatment, and to provide technical services to state and interstate agencies and to municipalities in the formulation and execution of their stream pollution abatement programs. Financial aid by loans to local agencies for the construction of pollution abatement works was authorized, but none was appropriated under the original Act. Enforcement of water pollution control measures was authorized, but only after state efforts had failed and with consent of the upstream state from which the pollution was originating. The Senate Committee on Public Works made a prophetic statement with regard to this bill:

> "...failure to accomplish adequate progress in pollution abatement under the terms of this bill, through cooperative efforts of the Federal and State agencies, will undoubtedly call for much stronger and more direct Federal enforcement measures at some subsequent session of the Congress."

The horrendous job of organizing, implementing, and carrying this new comprehensive program into the states was shouldered by Carl E. Schwob, Chief of the then embryo Division of Water Pollution Control. Under his masterful and dynamic leadership, the entire United States was divided into ten major drainage areas, with a field office staffed by four to seven engineers and scientists in each basin.

Before summarizing some of the accomplishments that were realized during the first three years of the Division's existence, it should be noted that no attempt was made to take a stand on any specific degree of waste treatment, but instead, every effort was expended toward achieving a feeling of cooperation between the states, industries, conservation groups, and other Federal agencies. This period was an all-out attempt to sell the Golden Rule to the Nation's water users.

The following are excerpts from Mr. Schwob's statement to the Committee on Public Works of the House of Representatives, 82nd Congress, on May 20, 1952:

> "...I like to think of our multiple functions in three broad categories .... First, comprehensive program planning and development activities; second, execution of the comprehensive program; and third, technical services and research which support all other activities.

> "Under the first category,...we have issued reports covering the 226 basins in the United States, of which 146 are interstate.... These statements represent joint statements of the Public Health Service and the States involved...(and are)...comprehensive blueprints of pollution abatement needs. We have developed...a model State Water Pollution Control Act which was recommended by the council of State Governments for favorable consideration. ...we are participating in the Arkansas-White-Red and the New England-New York Inter-Agency Committees.
>
> "Under the second category, execution of the comprehensive program...we have...worked directly with State agencies to bring about solutions to interstate pollution problems...encouraged the formation of regional pollution-control councils...(at least one of which has)...adopted (for its area) uniform water quality objectives and treatment works design standards...stimulated pollution control activities within the States by making Federal funds available for studies, surveys, and research.
>
> "Under the third category, "Technical Services and Research," we have...set up a National Technical Task Committee to work directly with industry...and placed under construction the Environmental Health Center at Cincinnati which is about 60 per cent completed...."

This program, which was successfully revealing and defining the Nation's water pollution problems was nearly scuttled within a year after the above report, by a temporary but devastating slash in Federal funds - Mr. Schwob's health failed, the basin offices were disbanded, and many of the highly skilled personnel transferred to other areas of activity. Could it be that the Public Health Service was approaching a point where it would have to take a stand in enforcing pollution abatement measures that would be costly for members of certain pressure groups? Perhaps we should have heeded the words of Plutarch (Lives - Crassus, p. 651) "Economy, which in things inanimate is but money making, when exercised over men becomes policy." Is the public ready for us to take a stand at this time? The cost of secondary treatment is even higher today than it was eight years ago; but then the public is more aware of the need for more clean water today - or is it?

Having made my point regarding the chaos that occurred during the spring of 1953, I must now qualify it by stating that Congress did extend the original act just prior to its expiration date in 1953 but after the basin office organization had been dismantled. Mr. A. F. Weiters succeeded Mr. Schwob during the reorganization period, and the program has surged forward since 1955 under the forthright leadership of Mr. Gordon McCallum. A second Federal Water Pollution Act, Public Law 660, was enacted by the 84th Congress in June, 1956. Since this Act is the foundation of our present Division of Water Supply and Pollution Control, we might well review its provisions to see if it will permit us to take a stand on secondary treatment.

The second Act is very similar to the first, with two significant changes: (1) authorization of Federal financial assistance in the form of grants (instead of loans) to municipalities for the planning and construction of needed sewage-treatment plants; and (2) a more workable provision for Federal enforcement where needed to clean up interstate pollution.

Our present program encompasses seven general areas pertinent to pollution:

1. Basic Data
   This program includes: (a) a national network of seventy-five stations on interstate streams to measure water quality; (b) inventories of water, sewage, and industrial waste facilities in the United States; (c) compilation of data on contract awards for water facilities, sewerage, and sewage treatment facilities to show what progress is being made in meeting the nation's needs, and; (d) economic studies to find ways of determining what pollution is costing the American people and the costs of controlling it.

2. Program Grants
   The Act authorized $3 million a year in annual Federal grants to support state and interstate pollution control programs; these agencies have used the grants, supplemented by two or three times the amount of the grant with local funds, for employing technical personnel, for purchasing special laboratory and field study equipment, for research, and for other purposes in administering state laws.

3. Construction Grants
   This program has been very successful in stimulating the construction of sewage treatment facilities, with authorization of $50 million annually. These have been made primarily to cities of 125,000 population or less, and local funds have been applied in a rate of about 6:1.

4. Research
   Aimed principally at pollution abatement, our research is carried on mainly at the Robert A. Taft Sanitary Engineering Center. Some of the projects under way include finding a cheaper and more efficient sewage treatment process and methods for freeing water supplies from viruses, detergents, insecticides, radioactive substances, and other substances which can make a water supply unsafe. The Act also provides for research grants to public and private research agencies, as well as qualified individuals.

5. Interstate Enforcement
   Where pollution of interstate waters endangers the health or welfare of persons in a state other than the one in which the pollution originates, the Public Health Service is empowered to take action to abate such pollution. Such action includes first, a conference with the state and interstate agencies involved; second, a public hearing before a board appointed by the Secretary; and finally, Federal court action.

6. Training
   The Sanitary Engineering Center gives short, intensive laboratory and classroom courses and holds seminars and conferences on new subjects of interest for the benefit of engineers, chemists, and other scientists from Federal and state agencies, municipalities, industries, and foreign countries.

7. Technical Assistance
   States which have requested technical assistance from the Division have received services such as full scale river surveys, evaluation of state laboratory operations, evaluation of new waste treatment processes, and special investigations into water-borne disease epidemics, and fish kills. Close liaison with the major industries of the Nation is maintained by the National Technical Task Committee on Industrial Wastes. It has two basic purposes: to serve as an advisory capacity to the Public Health Service, and second, to serve as a forum whereby the industrial representatives may exchange information on their common waste disposal problems and make regular reports to their sponsoring groups.

We have traced the course of the Public Health Service's water pollution control program from its birth, through its turbulent growing pains and finally its present nature, multiple-phase development. Our main purpose has been to reveal the complexity of the Nation's water pollution problem and the folly of any attempt to have taken a hard stand on universal secondary treatment up to the present time. Would it be wise to take such a stand now? Would it ever be?

Perhaps population density might be a criterion for determining when we should insist on universal effluent standards. Klein[1] compares England's use of effluent standards with the United States' program: "In the U.S.A., stream standards rather than effluent standards are preferred for legal purposes and this is understandable in a country where, in general, rivers are large and pollutions occur at wide intervals." A comparison of the average population density of the two countries bears him out, since that of England is 81 persons per square mile and the United States is somewhat less, 50.4. However, upon taking a closer look, we find that eighteen of our states have a greater population density than England. New Jersey and Rhode Island, the most densely populated, have an average of about 800 persons per square mile. At least four of the eighteen states now have some form of effluent standards. Incidentally, England has not strictly adhered to effluent standards, for Section 5 of the 1951 Rivers Act left open whether effluent standards, stream standards, or both should be prescribed.

Regardless of where we might draw the line for a minimum degree of treatment, we must expect sharp criticism for being unreasonable. For example, in implementing the Construction Grant program, the Public Health Service established rules and regulations that require treatment to remove, substantially, 100 per cent of settleable solids (primary treatment) as a minimum to be eligible for a grant-in-aid. Thomas R. Camp[2] has cited several instances where the receiving stream had sufficient flow to assimilate the wastes, and he used these examples to substantiate his following statement:

> "These (minimum requirements) tend to have the force of law compelling primary settling whether it is needed or appropriate to accomplish the required result in the receiving waters, and to divert attention from the much more important reason for sewage treatment, which is the destruction of pathogenic bacteria and viruses."

He has made a strong plea for chlorination only, where the dilution ratio is sufficient to handle the organic load in sewage: ".... post-chlorination of well settled sewage produces no better bacterial results in the receiving waters than does chlorination of comminuted raw sewage." We do not choose to argue the point, especially since we agree so heartily with his statement regarding the importance of destroying pathogenic bacteria and viruses; however, the following points are here listed as a token rebuttal to his criticism of our stand in the Construction Grants program: (1) The Public Health Service, by virtue of its role in carrying out Public Law 660, must give due regard to not only waters for public water supplies, but also the propagation of fish and aquatic life, recreational purposes, and agricultural, industrial, and other legitimate uses. (2) His comparison of the efficacy of chlorine on raw sewage and primary effluent involved the use of a laboratory blendor to stimulate a comminutor in breaking up the bacteria-laden clumps in raw sewage for more effective contact with the chlorine; a comminutor is not intended to, nor does it approach, the homogonizing action of a laboratory blendor. In actual practice, the center of these clumps might be expected to pass into the receiving stream without being contacted by the chlorine. (3) Laboratory beakers should not be considered as an adequate device for simulating the receiving stream; after-growth of chlorinated sewage bacteria may be expected to occur according to the turbulance, nutrient, and other characteristics of the particular receiving stream. (4) Malfunction or interruption of the chlorination would result in the raw sewage being discharged directly to the stream.

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[1] Klein, Louis, Aspects of River Pollution, p. 541, (1957).

[2] Camp, Thomas R., ASCE Sanitary Engineering Div. Journal, Vol. 87, SA1, January, 1961.

In the light of our experience in administering the Water Pollution Control Act in this country since 1948, the experience of England in applying effluent standards, and the sincere objections of qualified men like Mr. Camp, it appears inadvisable for the Public Health Service to take a stand and make secondary treatment mandatory. Instead, we should continue to encourage the states to classify their streams and thus reveal the degree of waste treatment needed to maintain the desired quality; to stimulate more intrastate pollution control activities by increasing the funds available for Program Grants; to stimulate a faster rate of construction of pollution-abatement structures (with a degree of treatment specified on a case-by-case basis in accordance with the receiving stream's use-classification) by increasing the funds available for Construction Grants; to increase the latitude and intensity of research on sewage and waste treatment that has the goal of producing an effluent that not only does not require dilution water but is free of toxic and pathogenic materials, at a reasonable cost; and finally, to continue all other phases of our current program with ever increasing enthusiasm and zeal.

By supporting the state programs for pollution abatement and control in their intrastate streams, the Public Health Service will need only to take a stand on the quality requirements of waters passing from one state to another with conflicting quality requirements. No across-the-board stand should be specified in advance, for each case must be decided on the quality requirements of the downstream state users.

Conventional primary, secondary, and even tertiary or polishing treatment are primarily limited to removal of oxygen-demanding organic materials.

Pre and post-chlorination may become mandatory to prevent viral epidemics if the rising trend in those diseases is proved to be waterborne. In the year ending September 3, 1960, nearly 34,000 cases of infectious hepatitis were reported in the United States - a 62 per cent increase over the preceding year. Also, the current Public Health Service program of nationwide surveillance of fish kills has revealed that 73 out of 185 cases were caused by agricultural poison and 57 of the 185 by industrial wastes. Surely something more drastic than conventional secondary treatment is indicated here. As a preventive health measure, it may be necessary to prohibit the discharge or land-use of any potentially toxic chemical to a stream until its degree of toxicity has been established.

In aggressively attacking the Nation's water pollution problems, we are assured of uninterrupted support (as contrasted with the spring of 1953) by the recent statement of President Kennedy in his address to Congress on February 23, 1961: "...I urge that this legislation strengthen enforcement procedures to abate serious pollution situations of national significance." Also by the legislature: Representative Blatnik, Chairman of the Rivers and Harbors Subcommittee of the House Committee on Public Works, has introduced H. R. 4036 to the 87th Congress to strengthen the Water Pollution Control Act. His bill would increase Construction Grants authorization to stimulate the construction of more sewage treatment plants and would increase the monetary limit for individual cities from $300,000 to $600,000; Federal enforcement would be extended to all navigable waters instead of the present interstate waters; it would establish a $25 million Enforcement Construction Grants Fund to be available for financially hard-pressed communities required to construct treatment facilities as a result of Federal enforcement action, such funds to be available over and above regular state allotments of construction grants. The bill also retains the states' primary rights and responsibilities for control of water pollution and increases Federal grants to state and interstate agencies for administration of their programs from $3 million annual authorization to $5 million. The stimulus of these Program Grants on state pollution control activities cannot be overestimated. To cite one of the many states which is making great strides in controlling pollution, California (which received $133,700 of Program Grant funds in 1960) has its Dickey Water Pollution Control Act. By vesting primary responsibility in nine regional water pollution control boards, with statewide policy formulation by the Water Pollution Control Board, it can take pride in an impressive eight-year record of progress in pollution control even while its population increased by 33 per cent.

Bills identical to Mr. Blatnik's were also introduced by Representatives Frank E. Smith of Mississippi, John D. Dingell of Michigan, and Senator Hubert H. Humphrey of Minnesota.

With this assurance of support, we can optimistically assume that the Public Health Service will have sufficient skilled personnel and funds to preclude the need for the simple expedient of taking a stand on mandatory secondary treatment. Instead, an intelligent case-by-case program of action will be taken to prevent or abate pollution in every problem basin in the Nation.

DISCUSSION

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We have read with a great deal of interest Mr. Davis' comprehensive analysis of the question of whether or not the Public Health Service should take the position that secondary treatment of wastes is mandatory. It does indeed require professional judgment and in many cases wisdom to reach the correct solution to both the method and degree of treatment to be used. Too often in the past we have had an insufficient amount of either. This has been caused in part by a general lack of understanding and foresight on the part of local public officials. The natural result of this has been a strong resistance on the part of the officials to ask the public to vote sufficient funds to permit the consulting engineer to design and build the facilities he knew were needed. Only in the last few years has there been an awakening to the fact that we can no longer let nature do the job of treating wastes with little help from those responsible for the problem.

The blame, however, cannot be placed entirely at the door of uninformed or unwilling local officials. It lies deeper than this. We in the field of water pollution control must accept our share of guilt since we did not adequately carry out our responsibilities in two ways. We did not put sufficient effort into education of the general public. Neither did we provide a clear-cut goal to show those concerned the importance of providing facilities to meet the need.

The education of the public has gone forward with great strides in recent years. As a result we find a receptive ear for our story on water pollution control needs [illegible].

Experience has shown that an informed public will act to correct deficiencies that exist. It is common knowledge that a bond issue for any public need will usually pass if there is sufficient effort put forth to inform the public of the facts. We have but to continue and expand our efforts along the lines of keeping the public informed and we will get their support in our efforts to control pollution. In fact we are likely to find that we have a public demand for immediate and vigorous action.

The matter of providing a clear-cut goal that will have the same meaning to every one concerned is not so simple. One cannot deny the value of establishing a clear-cut objective which leaves no room for misinterpretation or doubt. Many offenders have in the past and will, no doubt, in the future use misunderstanding or misinterpretation as an excuse to delay or avoid taking action to properly treat their wastes. It seems then that we must avoid taking the position that we are against sin. Nothing would be less productive than too broad an objective that can be interpreted differently by everyone depending upon his particular relationship to the problem. Our stated objective and guide lines must produce as nearly as possible the same interpretation by everyone who hears them.

To further complicate our problem we find ourselves in the predicament of how to define what constitutes secondary treatment. Are we to use the reduction of Biochemical Oxygen Demand to a specified level as the criteria? Must we also include the reduction of bacteria to a specified level? Will we limit the amount of dissolved minerals? Can we ignore color, temperature, or turbidity? What will we say about viruses, algae, and other forms of biological life? What about radioactivity and the many organic compounds? Will we set limits, either minimum for dissolved oxygen or maximum for other dissolved gases? If we are to say secondary treatment is required, we must define its meaning in terms of the above questions.

We have still other factors which complicate our problem. It is evident even to the layman that the amount of treatment needed will vary with local conditions. Not so easy even for the expert is the decision as to just how much is needed in certain cases. The large community or industry, even though it provides the best known treatment for its wastes, may still discharge an effluent which is more deleterious to the receiving water than the untreated waste from a small town. Are we then going to set an arbitrary requirement that will penalize these people in the small town in order to control to some extent the serious offenders? Our sense of fair play says "no."

Are we then to let the whole matter drop here? Is it too impractical and unfair to justify any move along the line of requiring more treatment? The solution is not that easy. We are still faced with the fact that our present progress is not sufficient to get the job done.

Let us step back and take a look at another aspect of the situation. The public is becoming alarmed about the critical situation which is developing with respect to our national water supply. They are asking for action and they are not noted for their patience once they have been aroused. As evidence of this we have the states where the authority of the State Health Agency has been given to another agency in matters of pollution control. Has this occurred because the health agency was too firm in dealing with offenders or was it the result of too lax a policy? There is no doubt in our mind that too lax a policy was the cause. We see evidence of this same feeling in the Amendments to Public Law 660 now under consideration in the Congress. Are we then going to lie gently back and be laid to rest, or are we going to stand up and do what must be done, knowing the difficulties involved and the criticisms that will be leveled at us. This may well be the choice that we must make in the near future. We believe that the Public Health Service is the best equipped and best qualified agency to deal with the problem of water quality and water pollution control and because we believe this, we suggest that the adoption of the following policy merits very serious consideration.

The policy shall be that:

1. The pollutor does not have an inherent right to discharge wastes into the receiving waters on the assumption that no damage results until it is proven that damage has occurred.

2. Complete treatment is mandatory unless the controlling agency declares otherwise in a given case or for a given area or stream.

3. The burden of supplying the facts necessary to make a decision will lie with the entity producing the waste.

We find ourselves reluctant to think in terms of such a strong policy. On the other hand, we have tried to accomplish control by means of education and persuasion with poor success at best. The above policy would have the advantage of a clear-cut stated objective which should not be misinterpreted. It would leave the judgment of the treatment needed in a given case in the hands of the persons most qualified to judge. And, it would have the advantage of forcing those concerned with the discharge of wastes to think first in terms of providing complete treatment rather than in terms of trying to get by with little or no treatment.

It may well be that some of the states are now operating under a policy similar to the one proposed. In any event, it would seem advisable to determine what policies are in use in the various states and how effective they have been before reaching a conclusion on the issue. There are other comments which might be made, both pro and con. This is certainly not an area that is either all black or all white, but we trust we have stimulated your thinking on the problem.

GENERAL DISCUSSION

POSTON: I think we're ready to take up where we left off. I think Bill Davis gave us an adequate background for our proposed policy regarding the use of low-flow augmentation for pollution abatement, and without getting back into that discussion because of time, I would like to come back to Mel Scheidt's proposals here and read them and see if we can't get agreement on them at this point. Mel, let's go through that once more. Let's read them once again so they'll know what we're talking about.

(Mr. Scheidt read his proposals.)

POSTON: I hope we are ready to make a decision as to whether this is acceptable to us. Are there any comments here?

EICHBERGER: Before we vote on that, Mel, I think we ought to take a look. In the policy statement number 2, we have a provision there which if they want to pay for the water they can use it as a substitute - if they want to pay for it on a non-reimbursable basis, am I right?

SCHEIDT: Item 2?

EICHBERGER: Yes. "Where pollution abatement by means of low-flow augmentation is proposed as a non-reimbursable planned purpose of a Federal project, only those pollution abatement benefits should be credited to the project which would be produced after the pollutors have first provided efficient secondary treatment of their wastes, or if this is not possible because of the type of wastes, then treatment to the degree economically permitted by existing knowledge ..." and so on and so forth.

SCHEIDT: No. I have deliberately dodged the issue of that situation where low-flow augmentation would be proposed as a substitute for treatment below the secondary level. Generally speaking in the earlier discussions we have frowned on the idea that we should allow dilution to be substituted for treatment, but if it did occur somewhere we said in the discussion the pollutor ought at least be made to pay. But in this it's left open, and if it should occur, the indication would be that they would have to pay for it. We're talking here, in Item 2, only about non-reimbursable credit.

EICHBERGER: That was the first point I had. Now, point number 2: If we're going to insist that every place that dumps sewage must have secondary treatment -

SCHEIDT: We don't insist there. All we say here is that we shall not allow credit to be given to a Federal project for low-flow dilution in those instances where it would be a substitute for secondary treatment.

EICHBERGER: What you're saying, then, is if we use low-flow augmentation, whether it's reimbursable or non-reimbursable, it can only be credited after secondary treatment, is that right?

SCHEIDT: That's right.

EICHBERGER: Okay.

SCHEIDT: We're not dealing here with the problem of what the state imposes on its own citizens. All we're saying is that if the Federal reservoir is going to be built, we can't give that Federal reservoir credit for pollution abatement below the secondary level under ordinary circumstances.

FLANNERY: If the additional flow in the stream changes the quality of the treatment - why should that not be counted as a benefit, deferring for the moment whether anyone will pay for it - the reimbursement question. Why is it not a recognized benefit, quantified and evaluated in the usual procedure?

SCHEIDT: I think you should, Jim. I don't have any objection to that. All I'm dealing with here is the problem of that situation where the dilution is going to be offered as a substitute for treatment.

FLANNERY: But suppose they put it in there for, say, three or four and it would permit five or six additional ones to defer the construction of a treatment plant.

SCHEIDT: This is just the point we're inveighing against. We don't want the situation to arise where a reservoir project is deliberately planned to take care of pollution. We don't want that to be used as a means of people avoiding their responsibilities.

FLANNERY: I'm not speaking of that either. Take the actual situation: If the stream quality is improved by this, why not recognize it - acknowledge it as a benefit - quantify it to whatever extent this can be done - and claim it as a benefit?

SCHEIDT: I'm not sure I understand what you mean, Jim. We have said in Item 1 that where the stream is in fact improved as a result of building the reservoir and regulating the stream for other purposes, that the credit should be taken. The benefit should be computed.

FLANNERY: But in your previous comment to Bill Eichberger - you knocked that out again.

SCHEIDT: No, I didn't. No, I didn't - not in any sense of the word whatever. There are two situations, Jim. In case of the incidental benefits - well, we can't help that. They're going to design a dam to provide low-flow augmentation to insure a proper depth of water so that you can float barges and carry coal or automobiles up and down the Missouri River. As a result of that at the low-flow period of the year the stream is now improved. As a result of this improvement the state may very well say to a local community, "Well, we've got so much water in there now, we're perfectly satisfied to have you just put in primary treatment, or what have you." Any benefit that can be computed as a result of that low-flow augmentation in the direction of pollution abatement I think ought to be properly credited as an incidental additional benefit to the project. However, in that situation, Jim, where you set out deliberately to design a Federal reservoir to take care of pollution abatement, what we're saying is dilution is not the equivalent of treatment and that pollution abatement credit for the Federal project should not be taken below the secondary level.

FLANNERY: What if a river basin authority - some unit large enough to handle it - would offer to buy dilution water which would be a substitute for secondary treatment. We'll refuse this proposition?

SCHEIDT: That's precisely the point we make. We should refuse to permit dilution to be substituted whether it be by river basin authority, or the state, or anybody else, because we don't believe - the paper here takes the position that dilution is not equivalent to secondary treatment - assuming that secondary treatment would be needed.

FLANNERY: If that comes to be the policy, then you'll have to be very explicit as to when secondary treatment and dilution aren't technologically substitutable - and that secondary treatment does something more and dilution does not. And if that isn't spelled out, I don't think it will survive.

SCHEIDT: We tried to spell it out here.

FLANNERY: I don't mean in these words. I mean with some substantiation in data - stream quality conditions - what do you remove - chlorides? What changes do you actually obtain from treatment that you don't obtain from dilution?

SCHEIDT: I am assuming that our technical experts can give us the data to back that up.

DE FALCO: I still feel that Item Number 1 is a little too all-inclusive and contradicts some of our original policy that we have adopted. I wonder if I could take a leaf out of John Thoman's book and suggest a change as follows: "Incidental pollution abatement benefits resulting from the operation of Federal projects for other purposes may be credited on a non-reimbursable basis to those projects, but such benefits should be computed for a limited time only." Leave out the postponement of any facility, because this contradicts our whole premises that we originally adopted.

SCHEIDT: I would reserve judgment for a minute, if I may, Paul, to ask whether anyone else wishes to comment on that?

THOMAN: I'd like to support that. I was going to suggest almost the same thing.

SCHEIDT: Well, I admit that it opens the door and invites controversy. I was simply trying to face up to some of the comments that I receive from the field, which move in that direction. But if you all feel that that condition would be more acceptable and would avoid the controversy, and if it would still have in effect the same philosophy here without the controversial part of it, I'm quite willing to accept it.

EICHBERGER: Mel, I want to comment on that little bit. I think one of the things we have to do here is be realistic. So we build a reservoir and we put in storage for low flow. Now, as we move through time below this reservoir there are going to be towns that will be growing, we think, that do not need secondary treatment now but may in the future. I think we should, as long as low flow might be provided at a lesser cost than secondary treatment facilities, until such time as secondary treatment becomes necessary, that maybe we should take into consideration the phasing in -

SCHEIDT: We've covered it here.

EICHBERGER: As the statement now stands in number 1, it's that way, isn't it, if I read it right?

SCHEIDT: Number 1 deals with the whole thing. We don't have the problem of phasing in in number 1. You just take whatever benefits accrue -

GEBHARD: Didn't you miss a point here, Bill?

SCHEIDT: You don't build it in - it's just an incidental by-product - navigation, power, what-have-you. As a result of doing these other things.

EICHBERGER: Well, I'm a little bit confused on the wording there - about the deferment of treatment facilities.

SCHEIDT: I'll read number 1 as it would now be modified: -

EICHBERGER: I know what the modification is - I mean as it stood.

SCHEIDT: We've already modified it. I've accepted that.

EICHBERGER: The only thing I'm concerned about is - in the modification it has prevented us from taking into account some real benefits that might accrue -

SCHEIDT: No, all it does - it still leaves it open. Take whatever benefits you want. Let me read it: "Incidental pollution abatement benefits resulting from the operation of Federal projects for other purposes may be credited on a non-reimbursable basis to those projects, but such benefits should be computed for a limited time only based upon a projection of total future demands upon the streams for water for all purposes." It just lifts out a controversial phrase which says, "even though construction of treatment facilities which would otherwise be required is thereby postponed." It just leaves that out.

EICHBERGER: Don't take this as an objection. I just wanted to be sure we weren't missing something.

POSTON: Are we ready to vote on whether this is acceptable as amended? I'd like to see a show of hands - who is in favor of this?

Who is not in favor, now?

SCHEIDT: Dick, do you have a point that would verify something in our minds?

VANDERHOOF: As a matter of implementing these projects I can see readily the difference between incidental and planned benefits, but why you must compute them differently, I don't know. I think it would be much simpler and more readily explainable to others that they both be determined in the same manner.

SCHEIDT: They're not. Incidental benefits might even go below the secondary level - but the planned benefits, we're not letting them go below the secondary level.

VANDERHOOF: Why not view them in the same manner?

SCHEIDT: Because later in the discussion of the manner in which the benefits are evaluated, we have pointed out that merely taking the pounds of BOD removed above the secondary level and assigning some arbitrary value to them wasn't necessarily a proper way of evaluating the worth or the benefits above the secondary level. But below the secondary level you would ordinarily have a planned continuous operation at any time. You just take the cost of putting in a secondary treatment plant, or a primary treatment plant, or whatever it is.

Above the secondary level you get into tertiary types of treatment and you may have to have what we talked of as a standby plant or other kinds of alternatives available as a means of getting at the evaluation. This is the reason in my mind why I separated the two. I felt that you had to treat them somewhat differently.

VANDERHOOF: Well, another one of my arguments is that incidental benefits - you can correct me since you've been in the Bureau of the Budget - I understand that incidental benefits are not included in the cost-benefit ratio and they are merely an influencing factor on the Administrator who wants to make a selection of projects.

SCHEIDT: That's true of all benefits of this kind - whether they're incidental or otherwise, unless they are deliberately authorized in the project.

VANDERHOOF: Now a planned benefit would definitely come into a cost-benefit ratio. Well, this is my point - why are we asking for trouble if we do get trouble on the difference? Because really, it's not going to affect the project at all - the incidental benefits.

SCHEIDT: Why do you now include these benefits in your reports to the Corps of Engineers? You include the benefits for pollution abatement - most of the project reports that I have read have been in the nature of incidental benefits - they couldn't be anything else. You put a value in them, but they do not enter into the benefit-cost analysis. They are submitted to the Congress as additional information of value in justifying or judging this project.

VANDERHOOF: This is correct but they are still computed in the same manner as if we would compute a cost-benefit ratio.

SCHEIDT: Well, that's all right. I still don't have any objections, except they are, in fact, incidental from the point of view of authorization of the project. They are not planned - they result by accident as a result of doing something else on the river. And even if you didn't have any pollution on the river, you'd still have this low-flow augmentation. And once you have modified the river, the river in effect, becomes whatever you have made it. It has assumed a new natural form. Then if a town grows up along that river and has some pollution, the state can recognize the fact that it has been modified now - it can be taken advantage of.

FLANNERY: I don't recall any Title III projects where these are incidental benefits -

SCHEIDT: We're not talking about Title III projects, Jim. We're talking about any project which the Corps of Engineers may ask the Public Health Service to comment on benefits for pollution abatement that may result from a project.

FLANNERY: But you have seen these reports and they were called incidental.

SCHEIDT: I'm not talking about Title III reports - I'm talking about all kinds of reports. Public Health Service for many, many years has been submitting reports to the Corps of Engineers - they used to flow through the Budget Bureau where I was for ten years, and I've seen many of them, and they comment in various ways on pollution abatement and other aspects.

FLANNERY: But now in the last two or three years, the pollution benefits in there have been all planned benefits.

SCHEIDT: No, they haven't.

FLANNERY: We say -

SCHEIDT: Not all of them, Jim. No, I would disagree on that - and I would have to refer to the field to find out, because some of the reports that come in have not been planned reports as a result of Title III. We've done two things on some of these reports. We have prepared a Title III examination and also commented to the Corps at the same time on pollution abatement aspects of that project. Not necessarily under Title III, and not necessarily planned.

POSTON: We'll have one more comment.

NOBE: I'd like to get this right here. The way it's now worded, I wonder if this is what it is intended to do: Benefits should be computed for a limited time only, but it doesn't say why they are computed for a limited time only. It's a pre-supposition which the projection may show that benefit could continue indefinitelv in this particular stream.

SCHEIDT: What I'm getting at here is the planning program ultimately catching up with the situation.

NOBE: It should say "if". _If_ the demand. Not pre-suppose that in every case it will. I know streams where it will never happen.

SCHEIDT: I accept that. Tell me exactly the wording.

POSTON: I think I'd like to close this off now, and get on to the conclusions of our meeting here.

SCHEIDT: We've accepted all of these now?

POSTON: I think we accept it all, and I hope you'll take into consideration Dick Vanderhoof's remarks.

SCHEIDT: Well, I won't disregard them.

POSTON: We have John Smouse's discussion on the earlier paper by Bill Davis.

KLASHMAN: John, I would like a clarification. I think I am in favor of what you said. Do I understand correctly that you're advocating that Public Health Service take the position that the Food and Drug Administration takes with industry, and that is if an industry has put out a product, it's up to the industry to indicate that this particular product, this additive that they're putting in is not going to hurt humans? But by the same token do I understand correctly that in what you are advocating when an industry is discharging a waste, it's up to them to present evidence to the regulatory agencies to show that what they're proposing to discharge is not harmful to humans?

SMOUSE: I think this is the policy we should sell industry and those concerned. Now I would be the first to say that we still should make every effort to assist them in producing any facts necessary to a proper decision. But I think it's important to pollution control to have this positive thinking that we must be sure what these wastes are going to do and how they can be controlled unless we're told we don't need to do certain things. It's an attempt in my mind to reverse this thinking of "we can throw it in unless someone tells us we can't." I might just give this as an illustration of the position I think we're into a little bit. Wally, and probably Dick, will remember when we were in school there used to be - boys used to poke fun at one of the local policemen - I've forgotten his name - but they attributed to him various sayings - and one of them I remember is "How many youse guys are in those bushes?" "Three." "Well, half of youse come out, and half of youse stay in there. If you don't do it, I'll get somebody what will." Now, as I see it, this is the position Public Health Service is in. We've got to control pollution, and if we don't do it, they're going to "get somebody what will." And to me this goal is a specific objective which can't be misinterpreted. It's going to be a part of trying to get this job done.

CLARE: John, you referred to "complete treatment". Did you use that term advisedly?

SMOUSE: Yes, I did. I'd like to say this: I was not in disagreement with Mr. Davis' paper, as you could no doubt tell.

KEHR: First of all, the statement that Mr. Klashman made relative to the Food and Drug Administration - it was not new. As a matter of fact, in an opinion prepared by the Attorney General of Missouri, the case was cited where the Supreme Court of a State - I believe it was Wyoming - actually took this position. That it was not up to the State Division of Health, or State Department of Health, to prove that what this city discharged would actually affect human beings. Rather, it was up to the city to prove that their wastes would not affect the human beings adversely. Really, what I got up to say was this: in discussing a water policy that the Service might adopt, or a goal - I would prefer to call it a goal, - it seems to me that very little has been said concerning the conclusions - or again, perhaps I shouldn't use the work conclusions - but concerning some of the statements that were included in the final statement in the recent conference on Water Pollution. I would like very much to hear some discussion of the possibility of establishing this as our goal. Are we going to wait until others take the lead in this matter - are we going to lag behind or are we going to take the position that has been suggested? Are we going to step out in the fore and take this position, that the goal - of the Service - shall be the treatment of water to the highest possible technical knowledge, rather than take the negative attitude that you can use the stream to its capacity?

POSTON: Mel Scheidt?

SCHEIDT: Just one supplement to Bill - that's all. I would urge strongly that anyone that has any doubt, go back and read again the report of the Senate Select Committee on Water Resources, and that, combined with the findings of the pollution conference of last December ought to clearly indicate if we don't do something about this, somebody "dad-gum" well is going to do it.

FLANNERY: I don't think there's any contradiction in the statement as to the most technically feasible treatment and using the stream to its maximum, because it would be a remnant of material in the effluent that would have an adverse effect on the stream, even after the best treatment, in most cases, when you go through the oxidation pond. So you'd still be using the stream to its maximum, after maximum treatment, and this is what low-flow augmentation would do - the maximum use of the stream would be increased. What you have done is not provide maximum with raw sewage - you have put maximum with the remaining BOD or whatever the remaining residue is after treatment. There's not a contradiction.

INTRODUCTORY STATEMENT

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I want to make a personal comment or two first. Personally, I'm highly pleased, of course, to see this group recognize the variety and competence of the talent represented here in this room today. Of the people that are here - and I could name a dozen, like Poston, John Thoman, Paul Reed and others - we can look back a few years and recall the kind of crowd that we got together and the size of that crowd - and look around here today. They're just as thrilled as I am, to look around this room and recognize that this is just a segment of our work, to talk to the guys that are here, to know the disciplines they represent, to know the intelligence and competency we have. I think it is a marvelous thing.

There's one point before we get into the discussion that I think might be worthwhile to discuss here. I think we have a real need, with the expanding program, new personnel, new disciplines, to do more along this line. No one here, I am sure, can go away without a feeling of having gained much. I ask this question: Would it be a correct concensus of this group that further work sessions of this type, on an appropriate subject to be covered in depth and aimed primarily at furthering the division's efforts faster and more expeditiously, be approved? Unless I hear to the contrary, I'm going to assume the concensus of this group is that we ought to have more of these. As a recommendation for the next one, it seems to me that a work session in comprehensive planning, including background, concepts, methodology, and the problems associated with execution of comprehensive plans - of carrying them out, of bringing about their fruition - would be a subject having high priority. I would very much appreciate again to have the record show the views of this group on (1) the desirability of having a meeting, and (2) whether or not this subject would be an appropriate one. Perhaps we might have a show of hands. (Unanimous agreement.) I think the record should show then that there was general concensus of the group that we have an additional meeting and that, as a suggestion, comprehensive planning and its full ramifications be the subject, Keith.

Now with respect to this task of summary, proposing conclusions and recommendations, one could attempt to summarize and conclude the eleven well-developed papers - but it would be very difficult to try to cover all this ground. We've taken as our task - and I say "we" here - this is the Portland office's contribution to this meeting. Alan Hirsch, who was not here but working back in the office, John Davidson, Jim Agee, and myself, took it as our task - not to summarize and conclude on all the points raised in the meeting but merely to take the key from the letter that Jerry sent out, and that was to the effect that the purpose of this meeting was to attempt to arrive at decisions and perhaps agreements on those things which might be termed standard indices methodology in order to bring about some general agreement in those areas in which we have common need in all of our work across the regions. With this, of course, I can then summarize the meeting against these points much easier. Taking this as a basis, the Portland staff took the workbook and reviewed and evaluated it, and prepared a set of review notes prior to the meeting. That's the first paper that you have. Then we had planned as the discussion carried on through these three days to take the discussions and summaries and try to bring out of them whatever other additions would lend substance to the determination of these common bases that we were looking for. This is the second set of papers. We have not completed all of the papers. Those now missing have been dictated, however, and they will be part of our record. Let's take a look at our first paper.

A REVIEW OF CONCLUSIONS AND AGREEMENTS FOR FUTURE ACTION

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These comments have been prepared on the basis of the papers in the Conference Workbook, to provide a starting point for the review of conclusions and agreements for future action. The discussions taking place at the conference itself will undoubtedly result in additions to and modifications of these advance remarks.

There can be little question as to the value of this conference in terms of providing a stimulating exchange of information. The basic assumption underlying these remarks, however, is as follows: that the major aim of this conference, over and above that of exchanging information, has been to contribute to the development of standardized procedures (to the extent feasible within local and regional variations in conditions) for use by the Division of Water Supply and Pollution Control in its water resources planning activities. The individual papers and the conference as a whole have been analyzed in terms of their relationship to this important goal.

The following review is a critical one; but its purpose is certainly not that of negative criticism per se. We recognize that it is relatively easy to delineate shortcomings, and that doing so is no sign of omniscience. This review is intended to aid in carrying out the assignment of arriving at meaningful recommendations for future action.

The development of a set of uniform procedures, encompassing the best available methodology, requires systematic and painstaking staff-work. It is apparent that a conference such as the present one cannot provide a substitute for this staff-work, nor, we expect, was it intended to. Obviously, it is understood that agreement could not be reached here as to whether each of the papers presented represents the best and most definitive information on its assigned topic, whether the conclusions reached are sound, or whether the topics assigned are the most pertinent to the needs of the program.

A brief review of the Conference Workbook is presented in an attached table. The following aspects of the papers are included in this review:

1. The contribution of each paper towards the development of standardized planning procedures.

2. The relationship of the topic of each paper to the overall planning process.

3. Suggestions as to some of the remaining needs in the development of standardized planning procedures.

These papers cover a variety of aspects of the subject, some narrow and others broad, in varying degrees of depth. A general conclusion is that, although some of the papers describe methodology in considerable detail, collectively they do not provide a systematic appraisal of water resources planning procedure.

The second aspect cited above illustrates this point. For the purpose of this analysis, the planning process has been simplified into four major elements:

1. Water requirements

2. Water resources

3. Water management technology

4. Water management planning

Water management planning is accomplished by selecting the best combination of water management alternatives to apply to the water resource base in order to meet water requirements.

As the attached table indicates, most of the papers dealt with the first element - that of forecasting water requirements (and waste loadings). Even with this emphasis, there are apparent gaps in coverage. The difficult, but important, topics of determining future water quality requirements for fisheries and recreation, for example, have not been discussed.

Papers on the water resource base were entirely lacking, yet a number of questions relating to the hydrology of low flow augmentation require exploration. The frequency and duration of drought flows to be used in assessing storage requirements provide an example.

Only one paper dealt with water management technology, and then specifically with waste stabilization ponds. Many alternative methods for both water supply and waste disposal will have to be examined, requiring the most careful analysis. Assumptions as to the extent to which recirculation of industrial process waters will be feasible in the future, for example, will have an important impact on planning.

Several papers discussed in broad terms policy guides to be used in planning, although, as might be expected, these conflicted to some extent. The specific mechanics of formulating a plan, however, were not elucidated in detail. Interest rates, methods of determining sewage treatment costs, and similar aspects of project evaluation requiring standardization were not defined.

The remaining needs mentioned here represent only a few of the areas which still require resolution; other needs will, no doubt, arise from the conference discussions. These needs range from topics in which really satisfactory procedures await the development of new concepts (e.g. economic value of water quality), to those in which well-developed techniques or information are available (e.g. costs of sewage treatment). In each case, however, existing information must be evaluated and a determination as to the best procedures made.

Any conference has inherent limitations as a device for coping with a conceptual task such as the one just cited. The contribution of this conference has been to yield a useful exchange of ideas and, perhaps more important, to emphasize the need for future staff studies. The prepared papers and subsequent discussions can merely adumbrate the needs for these studies. The most definite conclusion as to requirements for future action that can be reached is that the Division of Water Supply and Pollution Control should undertake the staff studies necessary to develop procedural and policy manuals which will provide guidelines for its field operations.

TITLE	CONTRIBUTION	ASPECT OF PLANNING PROCESS	SOME REMAINING NEEDS
Population Forecasting - Methodologies and Merits	Provides a method of forecasting population in Standard Metropolitan Areas, utilizing extrapolations of population trends.	Water Requirements	Coordination of the various economic techniques, including factors for translating economic data into water supply requirements and waste loadings, to provide a comprehensive framework for use in planning. Delineation of water quality criteria for various uses. Determination of future fisheries and recreation potentials and water requirements.
Growth Factors in Economic Base Studies	Provides a method of forecasting employment and population, utilizing relationships between sectors of the economy.		
Location Factors	Provides guidelines for assessing industrial location as a factor in forecasting industrial growth.		
Projecting Water Requirements in the Boondocks	Provides guidelines for forecasting industrial production, water requirements, and waste loadings for resource-oriented industries in rural areas.		
Agriculture - Effects on Water Demands	Provides factors to be considered in determining future requirements for agricultural water and the allocation of water for agricultural use.		
Estimating Future Water Demand	Provides factors to be considered in converting population data into municipal water supply requirements.		

Analysis of Water Resources
Conference Workbook (Continued)

TITLE	CONTRIBUTION	ASPECT OF PLANNING PROCESS	SOME REMAINING NEEDS
		Water Resources	Methods of low-flow prediction. Low-flow frequencies and durations to be utilized in assessing storage requirements. Effects of reservoir operation upon water quality downstream.
Must Water Treatment be High Priced?	Provides an assessment of waste stabilization ponds as a method of waste treatment.	Water Management Technology	Determination of future potentialities for water re-use and waste removal as means of meeting water supply and pollution control needs. Relation of flow augmentation practices to water management structures and operations of the Federal construction agencies.
Must Stream Quality be Maintained	Provides factors to be considered in developing policy objectives for pollution control planning.	Water Management Planning	Assessment of waste treatment costs. Interest rates for use in water supply, waste treatment, and multiple-purpose flow augmentation projects. Determination and expression of social and economic value of water quality. Policies for use in choosing between available water management alternatives.
Principles and Policies for the Evaluation and Reimbursement of Water Supply and Pollution Abatement Benefits from Federal Storage Projects.	Provides an assessment of the principles, policies and procedures available for use in project evaluation.		
Should the Public Health Service Take a Stand and Make Secondary Treatment Mandatory?	Provides factors to be considered in developing policy objectives for pollution control planning.		

With respect to the other papers that have been prepared, one by one, that have the clip on them, I'm not going to go over those, nor am I going to read all that material. I'm going to try to go back to the end paragraph where I used the personal pronoun to indicate in my mind whether or not there was a contribution or some specific information that met the initial guidelines that we were discussing; namely, the establishment of a standard, a guide, a single methodology, or some index that we could use as a common figure or common idea in all of our operations. In doing so - I'll try to hit the conclusions for each of these papers with the additional comments. By way of taking an over-all look at the table, first of all, you will notice that column 3, aspect of the planning process, papers were identified with the element of water requirements. In the area of water resources, there are no papers that we would identify with this particular aspect. There was one paper on water management technology, and three papers on water management planning. Paper number 1, Population Forecasting - Methodologies and Merits, provides a method of forecasting population in standard metropolitan areas, utilizing extrapolations of population trends. We have no different conclusion as a result of the discussion. Mr. Torget indicated at the start that this method is only one method, and that it's limited to standard metropolitan areas. Mr. Haywood in summarizing reiterated that the proposal was one method. We must accept the fact that this paper merely indicated one methodology, and that it was in relationship to another methodology, and basically, there are going to be several methods that all of us will use. It may be helpful for Keith's shop to identify those methods and the one that would be the more desirable to use under various conditions.

The second paper, Growth Factors in Economic Base Studies, provides a method of forecasting employment and population, utilizing relationships between sectors of the economy. John Davidson made it very clear that there were no indices that he would suggest with respect to these productivity factors that were commonly available for use everywhere. He recognized and pointed out that these were some of the indices, and he indicated again that these have to be applied with judgment and professional skill. Our task is to undertake by staff work the exploration of reasonable alternative methods with professional personnel responsible for their application. Keith made this point a number of times in the course of all the discussions, and I think that we are all agreed. I also suggested a review process to insure a check, before final acceptance, of the preparation of our reports and studies. I think, too, that with our regional operations we're going to have to develop some new form of a review process, so that merely the development of the report in the field doesn't make this the acceptable report. Whether or not our present review process could be further extended and given a more critical look is one of the projects, Keith, that needs to be given further thought.

Location Factors provides guidelines for assessing industrial location as a factor in forecasting industrial growth. There were no direct conclusions drawn from presentation comments. A very excellent paper, and it made a real contribution.

Projecting Water Requirements in the Boondocks provides guidelines for forecasting industrial production, water requirements, and waste loadings for resource-oriented industries in rural areas. Managerial decisions are most important in the location of specific industrial establishments and a large number of alternatives exist for managerial choice. In addition, there are other factors involved, such as resource base and international opportunities. This was minimized at the time, but it should not be, because in the Pacific Northwest, the largest of our industries, the pulp and paper industries, moves freely north of the line into Canada and south of the line into the United States. The managerial decisions there are of international scope, and are treated as simply one region; some of these factors we have to contend with can allow them to move north or south of the Canadian border. With respect to this matter, and in terms of the paper itself it seemed that we were trying to force an answer, when we try to pinpoint future industrial developments at specific locations. I believe there would be general concurrence with the idea that location should not be considered below some reasonable level. Jim made this point very effectively, giving consideration to the water resource system as a whole within that region, along with probability studies, linear programming and the like to provide possible refinements. I suggest that industrial development opportunities be viewed from the standpoint of the water resource base working backward from that base to approach probable developmental opportunities. By scheduling and priorities we can provide for development opportunities, giving full opportunity for managerial decisions for location within a region and allow developments to take their place in a free economy over a time. This is a shorthand statement of what we're doing in Atlanta. Atlanta might be a special situation, but we have a river basin in the Pacific Northwest 125 miles long, some 65-70 miles wide. It has 400 miles of desert to the east, it has essentially the ocean on the west, and we're dealing with this as a system. All of our studies are geared to making available managerial decisions in locations somewhere in this area. We're not trying to pinpoint where it should go - we're trying to make the system operate so they can go anyplace they want to. This is true also in many of the eastern waters in a good many of the waters in the middle west.

Agriculture - Effects on Water Demands provides factors to be considered in determining future requirements for agricultural water and the allocation of water for agricultural use. The comments did not suggest any specific item suitable for consideration as standard indices and the like. The paper and the discussion outline many useful points that need detailed consideration in carrying out our tasks and some of them need policy position development and implementation.

In Estimating Future Water Demands again we arrived at essentially the same conclusion.

I think by and large you will see the general sense of most of the papers was addressed to the development of varieties of situations - the opportunities - unless perhaps of specific elements that we might come to specific agreement on. The last two papers, however, brought us up short and our summary is not available. It will be included in the proceedings.

Dr. Gloyna's paper presents essentially one aspect of the technology of waste treatment, and discusses that in some detail, but does not get into the matter of exploring fully what the title might have implied, that is, the problems associated with low-cost or high-cost treatment. This, then, provides the summary of the workshop as far as we were able to go.

WATER QUALITY CONTROL AS A FACTOR IN WATER RESOURCE MANAGEMENT

Author: Keith S. Krause

Discussant: Lester M. Klashman

The paper was a general background paper providing long-term historical trends with respect to the development of water quality in relation to other water resource development programs.

The discussion suggested certain elements to be considered in the development of standards for general application in the Federal water pollution program. These were:

a. Low-flow augmentation: This is a policy question which must be decided through the legislative process. The meeting expressed no consensus. I know that the Division supports this aspect of legislation. The Kerr and Long bills reflect current Congressional viewpoints.

b. Why should not dilution be considered a solution to pollution? The answer was deferred for later discussion. This is a matter which needs specific staff study. It has many ramifications, and Paul Reed's comment that there is no "pat answer" is obviously correct.

c. The general problem of organization for planning: Mel Scheidt noted recent Senatorial views that there is no one best way to organize for river planning.

d. The relationship between the Public Health Service and state agencies other than the official pollution control agencies: James Flannery indicated the breadth of Public Health Service functions and implied that Public Health Service activities will ultimately require involvement in all state water resource programs because of the inherent scope of water quality activities. This would be especially true with respect to comprehensive planning in the broad water management field.

e. The ability of the Public Health Service to utilize effectively its information on bacteria, viruses, and other biological indicators: Bill Davis made reference to the importance of being able to bring to bear this information in support of the enforcement and comprehensive planning phases of our water quality management program.

POPULATION FORECASTING - METHODOLOGIES AND MERITS

Author: William E. Torget

Discussant: James J. Flannery

Mr. Torget indicated at the start that this method is only one method and that it is limited to Standard Metropolitan Areas. In his opening remarks, he noted two figures that might be established as standards at any particular time. These are national population projection figures and perhaps national projection figures for SMSA's. Torget indicated that five reviewers had stated his paper was interesting and useful as an approach to SMSA forecasting and that the method has as much validity as other methods.

John Thoman opened the discussion and stated that, as he understood the paper, the method was not being suggested as a substitute for the method which considered the resource base. Mr. Torget replied that it was not a substitute.

Mr. Weiser queried as to the application of the method to regional growth. Mr. Torget replied that he believed that the influence of regional growth was already included in the methods. He further felt that regional influences are influenced by SMSA growth rather than vice versa.

Mr. Flannery had a prepared paper for discussion and this will be included in the record. He then stated that the Basic Data Branch generally endorsed the method presented by Mr. Torget. He further noted that, as one moves to smaller and smaller areas, it becomes literally impossible to determine future growth. He indicated that the larger the area, the more rational would be the growth projection.

Mr. Scheidt then pointed out his view with respect to critical mass, i.e., above a certain size, cities begin to grow on themselves; below a certain size, cities may disappear. He concluded his comments by saying that the method discussed by Mr. Torget was merely one of several techniques in projecting growth.

Mr. Eichberger mentioned problems involving major shifts in the economy of regions from an agricultural to an industrial base. He also pointed out the danger of following growth trends without looking to the reasons and economic development base. In response Mr. Torget indicated his agreement again with this view and that the method presented by him was most important as a supplemental method.

Mr. Reed raised the question of the importance of changing technology.

Mr. Davidson referred to the distinctions that need to be made between the words, "forecast" and "projection."

Mr. Nobe raised the question of the utilization of this method, including the initial utilization of resource base, when applied to areas such as the Colorado Basin, or as applied to areas having a SMSA potential.

Mr. DeFalco noted the problems associated with the East. Here, he noted, there are many and large SMSA's; problems are essentially those of rebirth; basic resource is labor; and important factors are reconversion of industry to such things as electronics.

Mr. Kehr inquired as to the omission of data with respect to the 1930-1940 decade and also whether or not certain other economically impacted decades during the 19th century were considered in reviewing SMSA growth trends.

Mr. Dworsky mentioned additional elements dealing with social and governmental policies on growth rates and used as illustrations such factors as policies with respect to military bases; problems involving foreign affairs such as Cuba recently and the migration of population from Puerto Rico, etc., the depressed area and retraining proposals of the present administration and the effects of integration, social mobility and other migratory factors which are having a severe impact on our cities and, in many instances, are in effect redesigning them along lines considerably different than their past history would indicate.

Mr. Haywood, in summarizing this paper, reiterated that the proposal was one method. This was the most important conclusion to be drawn from the paper and the discussion.

GROWTH FACTORS IN ECONOMIC BASE STUDIES

Author: John H. Davidson

Discussant: James J. Flannery

Mr. Flannery had no significant additions to the basic paper presented by Mr. Davidson. He agreed with the general conclusion that productivity factors cannot be standardized. He viewed the model as a means of articulating better our views on this and other subjects. He noted that, even with respect to a single productivity factor, one cannot forecast individual factors much beyond ten years and that other more subtle factors begin to be more applicable. He suggested certain productivity factors deserve particular attention, such as those related to municipal and industrial waste treatment and to the matter of how efficiently industry can use water. He also suggested intensive study of BOD as a productivity factor in connection with our direct operations.

Mr. Hager inquired as to the factor of unemployment in Mr. Davidson's equations.

Mr. Torget discussed certain variations in selected productivity factors.

Mr. Nobe noted and discussed the limitations of single model forms and suggested the utilization of a range of models and the selection of an appropriate and desirable one. He also suggested the use of linear programming and IBM techniques for model development and testing.

Mr. Scheidt noted the problem implied in relating water use and employment. He suggested that the better relationship would be between water use and product. Mr. Davidson responded by indicating that in the Portland studies, both relationships would be used under appropriate circumstances.

Mr. Haywood commented on industrial water use as a critical factor. He indicated that industry has many opportunities for adjusting its water use and, in the final analysis, cost will play the important role in the management decisions involving water use. He further noted that BOD has been an expedient factor used in the Dallas studies; that it probably will be sometime before improved factors will be available.

Mr. Davidson restated his conclusions and the consensus of the group agreed with his four conclusions with the following addition, with respect to conclusion 1. He would restate that as follows: "A model is useful when it makes you think, but loses its usefulness when it replaces thought."

Mr. Alexander questioned why we reproduced methodology of other official agencies and why we could not accept their methods.

Mr. Krause commented on the necessity of using professional judgment in all of these matters; that it would be desirable to have several methods and that the end results might be used as a guide, balanced against experience and professional judgment.

Mr. Eichberger indicated his general opposition to models or standardization. He held that it was most important to use factors that are valid in the area under surveillance. He pointed out that he would beware of models to avoid rigidity and further that professional judgment must prevail. He indicated that the method was not important; that what is important is the selection of the proper and adequate method under specified conditions.

Finally, the over-all summary would seem to hold that we can not standardize forecasting methodology or productivity factors. Our task is to undertake, by staff work, the exploration and presentation of reasonable alternative methods with professional personnel responsible for their application. I also suggest a review process to insure a check before final acceptance in the preparation of our reports and studies.

LOCATION FACTORS

Author: Charles H. Hajinian

Discussant: Paul W. Weiser

Mr. Weiser opened the discussion by noting that industries do not always follow logic. He suggested it would be interesting to assess the effects of such factors as waste disposal, civil defense, and new transportation concepts.

Mr. Schreeder raised the basic question whether water was an important factor in industrial location. The reply was "probably not."

Mr. Svore asked whether this was due to the industries' past history. Mr. Hajinian replied that water as a factor in industrial location did not seem to apply to new industries.

Mr. Davis asked whether this might be so because water had been thought of as a raw material. Mr. Hajinian thought not. Mr. Davis then asked whether decentralization might be a factor in plant location; what were regulatory agencies doing about plant location; and is decentralization an important factor. Mr. Clare replied that the Ozarks are being considered as a location for a pulp and paper industry. The Public Health Service has studied the possibility of such a location at the request of the state agency. Mr. Clare then noted the example of taconite as a change in process method of affecting new developments.

Mr. Nobe asked whether the importance of water as a plant location factor would increase as recognition of water's importance increased. Mr. Hajinian replied that industry apparently is not worried. They would find an alternative water supply if other location factors were desirable.

Mr. Smouse commented that the problem just has not become critical as yet.

Mr. Dworsky suggested that we are still a water-rich Nation; that the industrial water problem is a long way from being critical; and that one reason why industries are not concerned is because they still have many choices for location. Mr. Hajinian commented that other factors are more important than water as a location factor.

Mr. Hager noted that it would have been useful to have information from industries that would not locate because of lack of water. Some might locate if water is made available.

Mr. Krause asked if Mr. Haywood would comment because of his background in industry. Mr. Haywood replied that, for one aspect, established plants might spend a great deal to protect an existing location.

Mr. Flannery commented that while a plant can always locate somewhere in the Nation, it may not be able to locate in a particular region.

Mr. Hajinian further commented that industry has much flexibility; that when water is short, industry will use less, even at a greater cost.

Mr. Smouse noted that it is a policy problem to decide whether the Nation should pay for water for industry in a specific region when there is the alternative of location in another region.

Mr. Eichberger noted that realistically the problem confronting the economist is to decide where industry will locate so that a plan for a specific river can be made.

Mr. Dworsky commented that state and national policy can in large extent determine the pollution aspects of industrial location, but the industry itself will determine its location when only water supply is a problem because of the flexibility for managerial decisions involving both technology and cost. A suggested answer from the social standpoint is to move toward maximum development of water sources.

Mr. Svore asked Paul Reed to comment on the importance of water from his viewpoint on the U. S. Study Commission - Texas. Mr. Reed replied, in part, that local statements on water needs are frequently too high and are not realistic.

Mr. Haywood noted that maximum development of a reservoir site may not be a favor to an area if there is no possible use for the water. Studies are not needed by the Public Health Service if maximum development is going to be practiced. Mr. Dworsky replied that Pacific Northwest agencies of the Federal government are actually planning for maximum development; that it does not lessen importance of Public Health Service studies. Mr. Scheidt suggested that optimum development is a better name than maximum development and Mr. Dworsky concurred.

Mr. Scheidt then commented that studies are being considered to analyze optimum development. He further stated we should be liberal in our approach to making water supply and pollution control estimates because it is safer to err on the high side. An error in that direction merely means a relatively short wait until the forecasted water need is reached.

Mr. Davis noted the importance of considering alternate uses for public monies.

Mr. Reed pointed out that we are too timid in using our knowledge; that we have good knowledge - better than most - and should use forcefully that which we have.

Mr. Krause noted that what we do now in our studies will have a very important future effect on the Nation. He emphasized the importance of our present work.

There were no direct conclusions drawn from the presentation and comments. There were presented considerable ideas for following by the Division staff.

PROJECTING WATER REQUIREMENTS IN THE BOONDOCKS

Author: Walter R. Hager

Discussant: Francis A. Jacocks

Mr. Jacocks generally agreed with Mr. Hager's paper and his conclusions. Mr. Jacocks expanded the subject by outlining a situation wherein the Corps of Engineers is currently considering basin development for flood control and where the local resources will not materially provide water use benefits. Mr. Jacocks posed a question and made a comment:

1. Should we consider longer useful life periods from 50 to possibly 100 years or longer for reservoirs?
2. Since we have a limited number of reservoir sites, we should develop these sites fully or at least make provisions for subsequent complete development. Complete development of reservoirs in areas where water use is not particularly needed will lead to interbasin exchange of water.

Mr. Dworsky commented that:

(1) The guides we now use in evaluating benefits have been established by existing laws.

(2) We should consider and develop changes we want. We hope to reach this objective by conferences with the Bureau of Reclamation and the Corps of Engineers.

(3) The Public Health Service has contributed materially to changes in water policy for municipal and industrial supply and we must continue to develop our suggestions on policy for presentation to those that can do something about these matters.

Mr. Scheidt noted that the Senate Select Committee has stated that it is desirable to preserve reservoir sites. Sites should be developed partially now, with the idea of full development to come later. We should purchase reservoir sites initially and preserve these areas for future storage developments.

Mr. Witherow asked when would we reach optimum development of water resources? (There was no direct response to this question.)

Mr. Hager further noted that the pulp and paper industry has adequate timber resources through the year 2010. This yield can and probably will be increased. Similarly, agriculture yields can be increased to keep pace with demand. Our energy resources, however, have a finite limit.

Mr. Ownbey noted that the benefits from reservoirs should not be extended more than 50 years. We should not mortgage reservoirs and reservoir sites and deprive our children of making decisions 100 years from now.

Mr. Rogers asked if we are considering comparative studies for plant locations.

Mr. Hager replied. No projections are based on a share of the national market and on raw materials available.

Mr. Thoman further commented that it seems that each area being studied is being considered for future pulp mill development. Are we overlapping in this area?

Mr. Flannery noted:

(1) The 50-year basis is not fixed.
(2) He is very dubious about projections greater than 50 years.
(3) Industrial development should be approached from a national picture.

Mr. Hager added that projections are based on four times the present use of pulp and paper mills.

Mr. Kehr suggested a statistical approach to timing industrial developments. Example: A 70 per cent probability that a mill will locate in an area by the year 1981.

Mr. Smouse suggested that someone should consider where pulp and paper mills should be located. He suggested that zoning of industry for water supply and water pollution control considerations be given more thought by stating that he doubts that reservoir sites are limited. We have more single-purpose sites than we are willing to admit. We should be able to find other sites and not limit certain areas for future development.

Mr. Gloyna disagreed that we have a plentiful number of reservoir sites. Studies in this region have shown that good sites are at a premium.

Mr. Vanderhoof agreed that the number of sites will vary from region to region.

Mr. Nobe asked that we not forget that there are other industrial developments possible and we should not over-emphasize projections of pulp and paper industries.

It was suggested that managerial decisions are most important in the location of specific industrial establishments, and that a large number of alternatives exist for managerial choice. In addition, there are other factors involved, such as resource base, and even international opportunities.

We are forcing an answer when we try to pinpoint future industrial developments at specific locations. It appears that there would be general concurrence with the idea that locations should not be considered below some reasonable regional level, giving consideration to the water resource system as a whole within that region, along with probability studies (linear programming and the like) to provide possible refinements.

It was suggested that industrial development opportunities be viewed from the standpoint of the water resource base, and working backward from that base, to approach probable developmental opportunities. By scheduling and priorities, we can provide for development opportunities, giving full opportunity for managerial decisions for location within a region and allow developments to take their place in a free economy, over time.

AGRICULTURE - EFFECTS ON WATER DEMANDS

Author: Willis G. Eichberger

Discussant: Garry L. Fisk

Mr. Fisk opened the discussion:

It is important to remember that the demand for water for irrigation is seasonal in nature. Irrigation in the West could be increased a considerable amount if based on irrigable acreage alone, but the actual increase will be based on the water available. Future expansion in the West will mainly depend on storage and interbasin diversion. There is wide diversity in water application rates and even wider diversity when the various laws are considered. There is a major amount of water that can be saved in the future through various devices now being investigated. Agriculture water supply might be of less quality than for municipal and industrial uses and this will have an effect upon future planning and storage requirements.

Much of the farming land near municipal areas is being converted to other uses. This will also require the conversion of water rights to meet these new uses for the land. The quality of irrigation water can increase the requirements for water. Also excess water sometimes prompts farmers to use additional water.

The cost of water will have a major effect on the use of water, but we must also consider benefits for recreation, fish and wildlife and such similar uses. These benefits can sometimes make a water control project feasible where it otherwise would not be. The cost of water in some projects is determined through a basin-wide accounting system and this system can reduce the cost to agriculture by permitting such water uses as power to pay a large part of the project cost. Water demand for agriculture will depend on both economics and social demands for water.

Mr. Svore asked whether the economics of agriculture use of water versus municipal and industrial use of water will overcome the political and legal emphasis now existing, which gives the priority to agriculture. Mr. Eichberger answered that agriculture does have the priority now, but the situation is changing and that, as people make demands for water for other uses, our laws will gradually change.

Mr. Torget asked if there was some short-cut way of estimating agriculture employment and production for Public Health Service use in estimating these factors. He had particular reference to a figure given for the Potomac study of 30 man-years. Mr. Eichberger answered that, according to the U. S. Department of Agriculture, by 1980 there will be no surplus in agriculture and this would be a useful guide in making our estimates. He also emphasized that we do not have time for complete studies of agriculture.

Mr. Witherow suggested that each of the areas starting studies on agriculture seek expert advice on making such studies in advance of the actual study effort.

Dr. Nobe discussed the time requirements on the Potomac study and indicated that instead of the 30 man-years, when the irrelevant factors were subtracted, the actual part of the study would have required about three man-years. Dr. Nobe then suggested that we consider having economic base studies prepared outside of the Public Health Service for each basin because the people in Public Health Service who are working on these studies may not be experienced in all areas of the economy.

Mr. Thoman stated that in his experience the Public Health Service has not always had success in going to outside agencies for this kind of analyses.

Mr. Weiser suggested that we should get help from the outside by relying on the estimates of other agencies.

Mr. Svore stated that, since we are in competition with other agencies, in effect, for water and its allocation, we should make sure that any outside help is both competent and concerned with regard to the Public Health Service's interests and responsibility. He gave an example which indicated that the judgment of another agency with responsibilities in the water field was mainly concerned with their own interests.

Mr. Svore asked if the Bureau of Reclamation gave consideration to the negative benefits which would result from project developments. Mr. Eichberger replied that, in his experience with the Bureau, he had not seen where the Bureau had considered damages to other water uses. Mr. Scheidt remarked that, in the preparation of the Bureau of the Budget Document A47, it was intended that negative benefits should be considered. Mr. Fisk cited a specific example where the Bureau of Reclamation had not considered negative benefits which had been outlined in a Public Health Service project report.

The comments do not suggest any specific items suitable for consideration as standard indices and the like. The paper and the discussion outline many useful points that need detailed consideration in carrying out our tasks and some that need policy position development and implementation.

ESTIMATING FUTURE WATER DEMAND

Author: Charles R. Ownbey

Discussant: Paul DeFalco, Jr.

Mr. Ownbey's paper presented factors which influence average per capita water demand. The following factors were considered in the paper:

1. Population
2. Time (trend)
3. General state of the economy
4. Living standards of families
5. Climate
6. Size of city
7. Price of water
8. Type and size of industry
9. Accuracy of measurements

Mr. Ownbey gave examples of experience in Region VII and concluded that average per capita water consumption will increase in this region. It was noted that the projected increase in consumption for this region is not consistent with the Senate Select Committee Document No. 7 which was published by the Headquarters staff of the Public Health Service. He asked that the Headquarters staff consider the preparation of further documents which more realistically describe per capita water consumption.

Mr. DeFalco started the discussion by indicating that the most logical method of estimating water demand was the one cited by Mr. Ownbey.

Mr. DeFalco read a statement from the Washington office, Basic Data Branch, concerning the Senate Select Committee reports.

1. The Washington office does not feel that the difference in values for water consumption are materially different.

2. The Washington office did not intend that the material submitted to the Senate Select Committee be used as it has been, especially on the release of regional data.

Mr. DeFalco continued by posing three questions for consideration by the group:

1. What are the regions' responsibilities in developing per capita water use consumption data?

2. What is the responsibility of Headquarters in developing such data?

3. How important is conformity between regions in developing per capita water consumption information?

Mr. Thoman stated that he has worked on this problem in Washington and data are available to show that per capita water consumption will not increase when the Nation as a whole is considered. (The remainder of the discussion centered around the problem of rising water consumption in certain areas and the use of the Senate Select Committee reports.)

The conclusions submitted by Mr. Ownbey were considered and there was general agreement on them, except that the comment involving the rise of average per capita use of water in Region VII should not apply to the Nation as a whole.

In conclusion, the paper provided a series of factors with respect to the subject under discussion but did not suggest specific indices or standards which would be usable in individual studies or investigations. The paper was provocative and should be helpful in pointing the way to developing improved data on this aspect of water resources planning.

MUST WATER TREATMENT BE HIGH PRICED?

Author: Earnest F. Gloyna

Discussant: Herbert C. Clare

In the discussion, Mr. Clare reviewed the high points of Professor Gloyna's paper and also the history of waste stabilization ponds and Public Health Service investigations into the application of these for domestic waste treatment. Group comments centered around the point of the cost of waste treatment facilities, and it was the general consensus that too many "gold-plated" conventional waste treatment plants have been used. In the future, more attention should be given to the application of less expensive waste treatment facilities and still maintain or accomplish the basic objectives. Mr. Klashman suggested that possibly the Public Health Service should consider a study to determine accurate cost information on necessary waste treatment facilities. Mr. Krause could not state what the Public Health Service Headquarters could do about this particular matter. The remainder of the discussion dealt with the technical applications of waste stabilization ponds.

MUST STREAM QUALITY BE MAINTAINED?

Author: F. W. Kittrell

Discussant: Paul Reed

Paul Reed agreed with Mr. Kittrell that we must examine our reasons for maintaining water quality. He stated that one of the problems in obtaining public acceptance of water quality programs can be traced to our failure to explain why water quality must be maintained. If we are realistic, we will not expect that stream quality will return to its original condition; but there is a reasonable middle ground based upon necessary downstream use. He argued that there is nothing wrong with using public emotion when such emotion results from a reasoned analysis of facts. He pointed out that we have hesitated too long to take specific positions, for we were afraid to use the information we have because of small gaps. We must use the information we have, now; for if we wait for perfection, it will be too late.

Reed took issue with the concern that municipalities and industries could not afford to maintain water quality because of the cost of treatment. He stated that an examination of the record would show that they can afford to do the things that they want to do badly enough. He also took issue with opinions that laws are not specific enough on water quality. He stated the opinion that legislators expected technical experts to give definition to general laws.

Mr. Weiser stated that the field of sociology should be consulted to get answers to the emotional response of people. Mr. Dworsky said that this was considered about ten years ago in a program suggested to the Navy. He further stated that in the Northwest we have recently tried again to get the social scientists to explore this problem but have not been able to interest them. We should continue this important effort.

Mr. Haywood questioned the need for rigid adherence to the principles discussed by Mr. Kittrell. He used the example of a plant which discharged untreated wastes into a stream without apparent harm to the stream. The question in this case is whether the state was doing wrong in permitting this to happen.

Mr. Thoman asked whether a company should be permitted to continue this practice and also what will happen when another company wishes to locate on the stream. Mr. Haywood replied that the situation should be subject to continual review. Mr. Svore indicated that municipalities and industries have the right to the reasonable use of a stream. Mr. Scheidt stated that the recreational business would have an important influence in future decisions on stream quality.

PRINCIPLES AND POLICIES FOR THE EVALUATION AND REIMBURSEMENT OF WATER SUPPLY AND POLLUTION ABATEMENT BENEFITS FROM FEDERAL STORAGE PROJECTS

Author: M. E. Scheidt

Discussant: Lloyd W. Gebhard

Mr. Gebhard briefly discussed the paper and pointed to the fact that we definitely need a policy and standards for the evaluation of low-flow benefits. He cited proposed legislation which will provide for the low-flow augmentation at Federal expense, and he indicated that these laws will certainly be adopted in the future. Mr. Gebhard suggested that, since this paper is in draft form and may well become the basis of a Public Health Service policy statement in evaluating low flow, the group should consider the primary concepts and recommendations which were developed by the author. The group was asked to consider the five basic concepts on pages 1 and 2 and also the four recommendations on pages 11 and 12. The group agreed to consider the basic concepts one at a time.

Items Nos. 1, 2, 3, 4, and 5 on pages 1 and 2 were adopted with minor changes. The change in Item 2 was as follows: "Dilution is not a substitute for waste removal but should be looked upon rather as a supplement to the program of adequate treatment." Number 5 was changed to read: "In developing Federal reservoir sites, every effort should be made to conserve their full potentialities for optimum development." One additional concept was introduced and adopted by the group. It is as follows: "Water quality management is an integral part of the concept of planning for comprehensive river basin development." In this sense, quantity and quality are inseparable components. Consideration of the recommendations on pages 11 and 12 were postponed until the paper dealing with mandatory secondary waste treatment could be presented by Mr. Davis.

GENERAL DISCUSSION

SVORE: Leonard, you did a top-notch job, as we expected you to do, and knew you would do. Are there any questions?

THOMAN: This question of a review process - for your consideration I would like to express my views - this business of review of reports. Pollution reports or Title III reports need to be tightened up. I don't know how some of the other program directors feel, but while there's no question about the competency of the staff's conclusions - I think when we put one of these things out we are laying the Public Health Service's neck on the line, and I think that good judgment - not only in the region but judiciously applied in a situation in Washington or SEC, or both, needs to be added on the top of this thing. I don't know whether anyone else feels that way, but I feel rather strongly about it.

SVORE: Keith, do you have any comments on this?

KRAUSE: Only that I concur with Jack that this review process is somewhat a weak link in our system, which I would hope we could correct as rapidly as we can. I think what Jack is saying here is that you fellows in the region don't necessarily rely upon us to correct every possible error in judgment that might occur. I think if you look at these reports, just as Jack has said, as representing the Public Health Service's best effort, and do not look to us to find errors in here, we will then minimize the necessary review system all the way along the line. I certainly concur with Jack that this is a weak spot in our whole system. While I hate to go into the reasoning why, I think we all pretty well understand why. We will try to do better.

SVORE: Thank you. Any other comments?

I have a couple of comments to make in closing. When we started thinking about a workshop such as this we certainly had no idea that it would turn out to be so large. We were thinking of getting together with ourselves plus one or two from headquarters, and probably a couple from SEC to help us out with some of our thinking and discussion. When you build a better mousetrap, people will come to your door. We had a subject that needed discussing which was our mousetrap, and in that respect we had something that was of interest to everyone. We were somewhat surprised and pleasantly overwhelmed at the reception we got. We were not being so presumptious, incidentally that we thought Region VII should call a national conference on water resource development. We had no intention of doing that, and we hope no one considered it as such. We had our own problems and we thought this would be the best way to solve them. The results were far beyond our expectations and we are certainly very pleased with them.

I do want to say again that the basic thinking back of this and the topics that were taken and the individuals assigned to talk on them were the result of the thinking that went on in Bob Haywood's shop and primarily by Bob Haywood himself. We have him to thank for a very successful conference. Are there any more comments?

HAYWOOD: I have one sincere comment and that is my deepest appreciation for the participation of all of you. Without it we wouldn't have had a meeting.

SVORE: I am sure that the program the last few days speaks for itself and indicates that the Public Health Service has a lot of competence in the field of water resource planning. I want to thank you again. The meeting will stand adjourned.